

Effect of Four Weeks of Circuit Training on Physical Fitness Components and Body Composition Among Senior Secondary School Students

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Abstract—This study, entitled “Impact of Circuit Training on Fitness and Body Composition of School (16-18 Year Age Group) Students of Government Sr. Secondary School of Sirsa District (Haryana)” examined the impact of circuit training on fitness and body composition of school students of 16-18 Years of Government Sr. Secondary School located in Sirsa District, Haryana. A total of 50 students were assigned to an experimental group and a control group using a quasi-experimental design. The experimental group underwent a circuit training program for 4 weeks, while the control group did not participate in any training. The researchers evaluated muscular strength, muscular endurance, cardiovascular endurance, flexibility, and body mass index (BMI). Data were collected using standardized fitness tests such as pull-ups, sit-ups, the 12-minute run/walk test, and the sit-and-reach test. The analysis of data was performed by using statistical techniques such as mean, standard deviation, and so on. According to the findings, circuit training significantly improves the total component of physical fitness and body composition.

Keywords—Circuit Training, Physical Fitness, Body Composition, Muscular Strength, Muscular Endurance, Cardiovascular Endurance, Flexibility, Body Mass Index (BMI)

I. INTRODUCTION

Encouraging physical activity (PA) in various settings can improve health and create healthy habits in populations [1]. Physical inactivity and sedentary behaviour are risk factors for non-communicable diseases (NCDs). Growing evidence shows that they may play a role in the onset of disease, [2], [3].

Research has largely determined the effectiveness of physical activity (PA) in preventing NCDs. However, the global rate of insufficient PA increased from 23.4% in 2000 to 31.3% in 2022 [4]. According to the WHO’s Global Action Plan of 2018- 2030, workplace interventions can be used to combat this.

The workplace environment is challenging, as it requires employees to spend 70–85% of their working hours in a sedentary posture [5], [6]. Studies have shown that occupational sitting is greater than non-occupational sedentary behavior, which hinders participation in PA [7]. Thus, the workplace is a priority setting for PA interventions aimed at enhancing workers’ health. The objective of Ateneo in Movement: Ensure an Active Lifestyle at the University of L’Aquila.

Circuit training (CT) is a WPAP strategy consisting of a series of exercises performed at moderate-to-vigorous intensity, with minimal rest between

exercises. It is considered a time-efficient workout. Studies have shown that CT has a positive impact on cardiorespiratory fitness, physical function, body composition and anaerobic performance. This is a more effective step compared to usual walking in body composition and muscle mass.

The integration of CT with mobility sessions is particularly relevant in an office setting, where time spent sitting does not refresh flexibility and postural function. Research shows that workplace-based flexibility programs reduce musculoskeletal discomfort and impairments in work-related musculoskeletal symptoms and range of motion among office workers.

Universities make great WPAPs as they have the right facilities, flexible timings, and a health-conscious crowd. They offer controlled environments for systematic implementation and evaluation. Workplace Wellness and Productivity Programs improve employees' sleep, reduce stress and anxiety, boost job satisfaction, and increase productivity. [21] They also improve collaboration among employees at the workspace 22.

A combined intervention of CT and mobility is suited in the university environment as it can adapt and uses less time. Earlier mumbo jumbo showed inability to find time as the main barrier for exercising at work place22. Also diversity in the program helps in making them engaged in the exercise23. The flexibility of this combo makes it very adaptable to levels of fitness and schedules and can be ideal for universities. As far as we know, there are not many studies that use CT and mobility to design physical activities for adult university employees.

With that, the objective of this study is to analyse the impact of a 4-week circuit-training intervention on fitness level and body composition in students.

It was hypothesized that the circuit-training group would show improvements in muscular strength, muscular endurance, cardiovascular endurance, flexibility, and body mass index compared with the control group based on earlier evidence.

II. MATERIALS & METHODS

A. Research Design: The research design uses a quasi-experimental comparative approach with pre-test and post-test assessments for an experimental group and a control group from government secondary schools within a quasi-experimental framework. It aims to measure health-related physical components influenced by environmental and cultural factors. The goal is to raise awareness of physical education's role in health standards and improve healthcare quality.

B. Source of Data: The data for this study were gathered from students attending the Government Senior Secondary School in Sirsa district, Haryana.

C. Sampling Method: This study was conducted through a purposeful sampling method.

D. Participants: Fifty students from various Sirsa district government S.S. Schools, aged 16-18, were purposively sampled for the study. They were divided into two equal groups: 25 in the circuit-training group (CTG) and 25 in a control group. The researcher consulted with experts during the selection process.

E. Variables: To obtain an idea about the problem, and to know the related research work, the researcher reviewed the sources like research papers, books, journals, magazines, etc. on sports training, resistance training, and circuit training. Following consideration of feasibility, availability of instruments and relevance to the present study, the below-mentioned key variables were selected for the study.

Understanding these variables helps us understand different types of physical fitness and how they affect performance and health.

F. Tools and Techniques

G. Criterion Measures: According to the expert in physical education, sports sciences, and on literature relating to contemporary training methods, the following test items have been chosen by the investigator as criterion measure. The selected tests are suitable, fitting, and ideal for evaluating the basis factors.

The battery of evaluations and the AAHPERD health technique was standard. The tests were described in detail including purpose, apparatus, evaluation and recording procedure.

1) Muscular Strength—Pull-Ups

Purpose: This exercise is designed to assess the muscular strength of the arm and shoulder muscles.

Equipment: A chin-up bar is required for this test.

Procedure: To perform the pull-up, start with arms fully extended and grasp the overhead bar using either an overhand (palms facing away) or underhand grip (palms facing toward). Raise your body until your chin passes the bar, then lower back to full extension. Perform smoothly without kicking, leg bending, swinging, or jerking. Aim to do as many full pull-ups as possible.

Score: Record the total number of correctly completed pull-ups. Additionally, note the type of grip used during the exercise.

2) Muscular Endurance—Sit-Ups: Purpose: This test measures the endurance of the abdominal muscles.

Equipment Needed: An exercise mat or a carpet and one assistant.

Procedure:

1. The participant lies on their back with feet approximately 12 inches apart and knees bent.

2. The hands are placed behind the head, with fingers intertwined.

3. An assistant holds the participant's ankles to ensure the feet remain in contact with the floor.

4. Upon starting the test, the participant begins performing sit-ups, counting each repetition aloud.

5. The participant must return to the starting position by touching their chest to their knees.

6. The test begins on the command "Prepared, go!" and runs for a duration of 60 seconds.

7. The test concludes when the assistant calls out "Stop!"

Scoring: The final score is the total number of correctly executed sit-ups completed within the one-minute timeframe.

3) Cardiovascular Endurance—12-Minute

Run/Walk Test: Purpose: The 12-minute run and walk test is designed to assess aerobic fitness, specifically measuring the body's efficiency in utilizing oxygen during physical activity such as running.

Equipment Needed:

- A flat oval or running track
- Marker cones for distance estimation
- Recording sheets for data collection
- A stopwatch for timing the test

Procedure: To conduct the test, place markers at designated intervals around the track. These markers will help participants gauge the distance they have covered. Over a span of 12 minutes, participants are encouraged to run as far as possible; walking is permitted if necessary, but they should aim to maximize their distance.

Scoring:

The results of the 12-minute run-and-walk test can be interpreted using Cooper test norm tables, which provide general benchmarks for evaluating adult performance. Additionally, two formulas can be

employed to estimate VO₂max (measured in ml/kg/min) based on the distance covered:

- For distance in miles:

$$\text{VO}_2\text{max} = (35.97 \times \text{miles}) - 11.29$$

- For distance in kilometres:

$$\text{VO}_2\text{max} = (22.35 \times \text{kilometres}) - 11.29$$

This test is a valuable tool for assessing aerobic capacity and can be useful for fitness assessments and progress tracking.

4) Flexibility—Modified Sit-and-Reach Test:

Purpose: The Modified Sit-and-Reach Test is designed to assess the flexibility of the hips and lower back, as well as the extension of the hamstring muscles in the legs. The goal is to determine how far an individual can extend their fingertips past their foot line while keeping their legs straight.

Equipment Needed:

- Flex measure case with a yardstick and tape
- Score sheet
- Helpers to assist with the test

Procedure:

1. Position the 15-inch mark of the measuring stick in alignment with a line on the floor, securing the finish of the measuring stick to the floor with tape, ensuring that the flex measure case is placed face down.
2. Sit down and position your heels directly aligned with the near edge of the 15-inch mark. Slide your seat back beyond the endpoint of the measuring stick.
3. Have a partner stand behind you and press their toes against your heels for support. Additionally, have helpers on each side to help keep your knees locked in place as you prepare to stretch.
4. With your heels no more than 5 inches apart, gradually lean forward, pushing the flex measure case as far down the measuring stick as possible using the fingertips of both hands.

5. Take note of the distance measured at the outermost edge of the case.

Scoring: The test score is determined by the best of three trials, measured to the nearest quarter inch.

5) Body Mass Index: Purpose: To assess the proportion of the body.

Procedure: Formula is used to measure body mass index. However, prior to that, the individual's body weight and height are to be measured and recorded.

The formula is as follows:

$$\text{BMI} = \text{Weight (kg)} / \text{Height (m)}^2$$

Scoring: After calculation, the score of BMI is expressed in the form of index.

Weight:

Equipment: Weighing machine

Procedure: The subject is asked stand erect on the platform of the weighing machine with equal weight on both feet. The weight of subject is usually recorded accurate up to 0.05 Kg. is maintained

The data pertaining to the study was collected by administering the tests for the selected variables. Before the collection of data, the subjects were given a chance to practice the prescribed tests so that they could become familiar with the tests and know exactly what was to be done to ensure uniform testing conditions. The subjects were tested in the morning, and data was collected.

H. Orientation and Reliability: Before the test, the investigator met with subjects for thorough explanations of the study's purpose, significance, and procedures. Each subject agreed to participate fully, was excited, and used testing tools to familiarise themselves with the protocol.

RELIABILITY OF DATA

To ensure the reliability of the data, several measures were implemented, including assessing the reliability of the instruments, testers, and subjects involved in the study. This approach helps

to ensure that the findings are credible and trustworthy.

INSTRUMENT RELIABILITY

Regarding the instruments utilised for estimating the factors, testaments of precision were obtained from instrument-testing organisations. Furthermore, dependability was established by recalibrating the scale using known factor measures where required.

TESTER'S RELIABILITY

The investigator ran practice sessions with experts to ensure the method's reliability. The researcher, aided by experienced professionals, took all measurements. The test-retest process confirmed the analyser's quality. The tester correlated data from ten subjects to verify reliability. Subject well-being was prioritised before each test to ensure consistent outcomes

Group / Item	Treatment / Details
Experimental Group I	Circuit Training (CTG)
Control Group II	Not engaged in any specific training programme
Training Duration (90 minutes)	Warm-up – 15 minutes; Instruction/Treatment (Training) – 60 minutes; Cool-down, Correction and Clarification – 15 minutes
Training Sessions per Week	Six sessions (Monday to Saturday) in the morning
Total Length of Training	Four weeks

Tables identified Group I as Circuit Training (CTG) and Group II as the Control Group (CG), presenting the well-organised schedules for Group I. Circuit training was used six days a week (Monday through

Saturday) for four weeks. Each group followed their schedule with a 15-min warm-up and 15-min cool-down within each 90-min morning session. Weekly, the load progression was adjusted. The tables detailed the intensity, repetitions, sets, rest, and duration for each group.

I. Circuit-Training Program: In the first week, subjects completed a single circuit through eight stations with straightforward activities. They exercised for forty-five seconds at each station, then had sixty seconds to move and rest. They had five minutes between circuits, with two circuits total. Fifteen minutes were for warming up, and fifteen minutes for cooling down. Instructions were given immediately. The program lasted 1.5 hours each morning, six days weekly.

2nd week - the practice in the station was diminished from 45 seconds to thirty seconds.

In the 3rd week, the training programs were maintained as in the 2nd week.

In the 4th week, the exercise time was the same as in the previous weeks, thirty seconds, but the set was increased from two to three sets, and the rest between circuits was the same as in the previous weeks.

The circuit training was given only in the morning session for six days of a week, for a period of four weeks. In the evening, the subjects were allowed to participate in their routine sports activities.

J. Administration of Tests: The examiner gathered with the subjects before testing, explaining the study's purpose, significance, and testing requirements to ensure understanding. The specialist clarified the physical-fitness test procedures, provided instructions, demonstrated each experiment, and answered questions. Test scores were collected, organised, and statistically analysed for significant results.

K. Statistical Analysis: The study involved an analysis of data to assess the impact of a training program on five selected components of physical fitness among students at the Government. S.S. School in Sirsa district, Haryana. To conduct this analysis, various statistical methods were employed, including calculating means and standard deviations and performing ANOVA.

The formulas used for these calculations are as follows:

- Mean (M) is calculated using the formula: $M = \Sigma X/N$, where ΣX represents the sum of all data points, and N is the number of data points.

- The standard deviation (S.D.) is determined with the formula: $S.D. = \sqrt{\Sigma D^2/N}$, where D represents the deviations from the mean.

- ANOVA (Analysis of Variance) involves a four-step process to evaluate differences among group means.

- Additionally, the t-test is calculated using the formula: $t = (m_1 - m_2) / \sqrt{[(SD_1/N)^2 + (SD_2/N)^2]}$, which compares the means of two groups. This comprehensive approach enables a thorough analysis of the training program's effectiveness on students' physical fitness.

L. Weekly Training Schedule

TABLE 1

CIRCUIT-TRAINING SCHEDULE—WEEK 1

Sr. No	Exercise Circuit station	Exercise in each station	Rest between exercises and change to another	No. of sets	Repetitions between sets
1	Skiping	45 sec	60 sec	2	5 min
2	Step-ups	45 sec	60 sec	2	5 min
3	Squat thrust	45 sec	60 sec	2	5 min
4	Push-ups	45 sec	60 sec	2	5 min
5	Double knee Duck jumps	45 sec	60 sec	2	5 min
6	Sit-ups	45 sec	60 sec	2	5 min
7	Shuttle run	45 sec	60 sec	2	5 min
8	Jump and turn	45 sec	60 sec	2	5 min

TABLE 2
CIRCUIT-TRAINING SCHEDULE—WEEK 2

Sr. No	Exercise Circuit station	Exercise in each station	Rest between exercises and change to another	No. of sets	Repetitions between sets
1	Skiping	30 sec	60 sec	2	5 min
2	Step-ups	30 sec	60 sec	2	5 min
3	Squat thrust	30 sec	60 sec	2	5 min
4	Push-ups	30 sec	60 sec	2	5 min
5	Double knee Duck jumps	30 sec	60 sec	2	5 min
6	Sit-ups	30 sec	60 sec	2	5 min
7	Shuttle run	30 sec	60 sec	2	5 min
8	Jump and turn	30 sec	60 sec	2	5 min

TABLE 3
CIRCUIT-TRAINING SCHEDULE—WEEK 3

Sr. No	Exercise Circuit station	Exercise in each station	Rest between exercises and change to another	No. of sets	Repetitions between sets
1	Skiping	30 sec	60 sec	2	5 min
2	Step-ups	30 sec	60 sec	2	5 min
3	Squat thrust	30 sec	60 sec	2	5 min
4	Push-ups	30 sec	60 sec	2	5 min
5	Double knee Duck jumps	30 sec	60 sec	2	5 min
6	Sit-ups	30 sec	60 sec	2	5 min
7	Shuttle run	30 sec	60 sec	2	5 min
8	Jump and turn	30 sec	60 sec	2	5 min

TABLE 4
CIRCUIT-TRAINING SCHEDULE—WEEK 4

Sr. No	Exercise Circuit station	Exercise in each station	Rest between exercises and change to another	No. of sets	Repetitions between sets
1	Skiping	30 sec	60 sec	3	5 min
2	Step-ups	30 sec	60 sec	3	5 min
3	Squat thrust	30 sec	60 sec	3	5 min
4	Push-ups	30 sec	60 sec	3	5 min
5	Double knee Duck jumps	30 sec	60 sec	3	5 min
6	Sit-ups	30 sec	60 sec	3	5 min
7	Shuttle run	30 sec	60 sec	3	5 min
8	Jump and turn	30 sec	60 sec	3	5 min

III. CONCLUSION

The manuscript reports that a structured four-week circuit-training program can improve selected health-related fitness components and body composition among senior secondary school students. However, the source manuscript does not include the numerical results tables required to verify effect sizes, statistical significance, or between-group differences. These data should be inserted before journal submission.

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