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THE EFFECT OF PLYOMETRIC TRAINING VERSUS AEROBIC EXERCISE TRAINING ON BODY MASS INDEX (BMI) AND CARDIOVASCULAR FITNESS IN OVERWEIGHT SCHOOL-GOING ADOLESCENTS: A COMPARATIVE STUDY

Dr. Sonia Bhatia[1], Dr. Sandipkumar Parekh[2]
[1]PhD Scholar, Faculty of Physiotherapy, Parul University, Waghodia, Vadodara, Gujarat, India.
Email: bhatia_sonia205@yahoo.com
[2]Professor & PhD Guide, Parul Institute of Physiotherapy and Research, Faculty of Physiotherapy, Parul University, Vadodara, Gujarat, India. Email: sandip.parekh28008@paruluniversity.ac.in

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ABSTRACT

Background: Overweight and obesity are characterized by an excessive buildup of fat, which poses significant health hazards, including alterations in body mass index and reduced cardiovascular fitness. These conditions are increasingly prevalent among adolescents and warrant targeted intervention strategies.

Aim: This study was designed to assess the comparative effects of plyometric training versus aerobic exercise training on BMI and cardiovascular fitness among overweight adolescents in Anand city.

Method: In total, 30 overweight adolescents from schools in Anand, Gujarat, were recruited. Group A underwent plyometric training, while Group B took part in aerobic training. Both groups participated in 16 supervised sessions over four weeks (four sessions per week on non-consecutive days). Pre- and post-intervention assessments included BMI measurements and the Queens College Step Test to evaluate cardiovascular fitness.

Results: Group A (plyometric training) showed greater improvements in both BMI and cardiovascular fitness compared to Group B (aerobic training). The mean post-intervention values were 85.38 ± 15.4 for Group A and 76.51 ± 10.52 for Group B, indicating statistically significant improvement in the plyometric group.

Conclusion: Plyometric exercise training demonstrated superior efficacy in reducing BMI and enhancing cardiovascular fitness among overweight adolescents compared to aerobic exercise training, suggesting its potential as a more effective intervention strategy in school-based fitness programs.

INTRODUCTION

The definition of obesity provided by the World Health Organization (WHO) is” An accumulation of fat that is either excessive or abnormal that poses a risk to health (1).” Excessive fat is now a serious public health concern, a global epidemic, and a worldwide phenomenon. India is experiencing a transformation in nutrition and economy that correlates with a reduction in performing physical day to day activity and a modification in dietary habits, leading to increase in the prevalence of excessive weight (2). One of the risks to public health is obesity, which is more common in emerging nations due to urbanization and industrialization, while the prevalence in India is observed to range between 10% and 15%. Key public health amongst children is obesity, giving its dramatic risk over the past few decades, causing health consequences and accompanying negative effects. The most prevalent form of malnutrition is perhaps obesity among children and adults in developing countries (3).

Abnormal growth of adipose tissue due to fat cell enlargement is obesity (hypertrophic obesity) or overweight or cell number increases (hyperplastic obesity) or a combination of both are major factors in causing obesity or overweight. Not only is there an excessive amount of fat stored in the body, but also regional fat distribution within the body differs amongst people with obesity. The rise in fat due to weight gain is related to an increased probability of developing obesity and the chance of numerous health conditions. Distinguishing between those that result in an increased risk of 'android obesity' or 'ab- normal fat distribution' is less useful from gynoid (4). Very few studies are being conducted in other locations where lifestyle changes associated with the economic and nutritional transition are also being experienced. Research conducted in India has mainly concentrated on children residing in urban regions. Additionally, other studies from India indicate that the obesity rate among adolescents stands at 6.8%, while 17.1% of adolescents are classified as overweight (5).

In developing countries, the primary public health concerns of the twenty-first century are overweight and obesity among children, with a troubling surge in their rates. The incidence of obesity in children aged 5 to 19 years has escalated to 18% in 2016, compared to just 4% in 1975, representing a three- fold rise from earlier statistics. The transition linked with changes in eating habits and physical activities among children is witnessed in India due to rapid nutritional transition and gain in economic development. The disparity in the prevalence of obesity can be significantly influenced by lifestyle changes among children from urban areas. A previous study carried out in Mysuru city, Karnataka, indicated that 8% of children at- tending school were identified as overweight, while 4% were categorized as obese. The implementation of effective preventive strategies is crucial for these emerging problems for a healthy transition of children to adults after suitable assessment of emerging problems. An environment conducive to obesity has emerged, and numerous children are currently experiencing it. The current trends of urbanization and globalization have led to a significant dependence among children across various socioeconomic backgrounds on heavily processed food items, which tend to be calories and not cost too much. Consequently, these food products are sources of deficient nutrients. Indian studies have reported many reports on the increase prevalence of obesity, from 5.5% to 17%, over the past few years. Few studies have been conducted in India from metropolitan cities as well as other cities under the influence of life. The World Health Organization has economic and nutritional transition amongst the children (6).

For Asian individuals, the World Health Organization recommends reducing the BMI cutoff levels to 25 kg/m² for obesity and 23.0 for overweight. If the secular trend persists, in the world there will be 38% overweight and 20% obese by 2030 if the trend persists secularly. The prevalence of obesity varies up to 10-15% in India. Around 3 million deaths each year occur as the underlying cause of overweight and obesity. If the current secular trend remains unchanged, it is anticipated that by the year 2030, 38% of individuals worldwide will be overweight and 20% will be obese. Prevalence of obesity varies up to 10-15% in India. Around 3 million deaths each year occur as the underlying cause of excessive body fat (7). Being overweight or obese has become increasingly common in children and adolescents around the world, ranking among the most common chronic illnesses in this age range and in adulthood (8). The World Health Organization (WHO) refers adolescence as the second decade of life, or the years between 10-19 years old. During this time, major changes in psychological, social, and physical development take place. About 1.2 billion people are adolescents in the world (9).

Overweight and obese adolescents are at risk for a number of morbidities, such as neuropathy, retinopathy, nephropathy, hypertension, and dyslipidemia. These conditions also raise the mortality rate in adulthood and increase the likelihood of psychological and social issues, such as low self-esteem, a negative self-image, increased depression, sleep deprivation, and a shorter adult life expectancy (10). From obesity 380 million children and adolescents worldwide affect. Among these, in 2016, WHO evaluation found that around one in six adolescents globally, aged 10 to 19, is overweight. In India, 15 million over- weight adolescents are currently estimated to be overweight, and more are expected in further years. Also, India, which is now the third most obese country in the world, elucidates the increasing growth of incidence of overweight children and adolescents. Recent statistics reveal that the proportion of adolescents (ages 10-19) suffering from obesity has surged from 16% to 29% in recent years (11). In 2022, more than 390 million children and adolescents between the ages of 5 and 19 were identified as overweight. The rate of overweight within this demographic has surged significantly from 8% in 1990 to 20% in 2022. This trend has been noted across both genders: in 2022, 19% of girls and 21% of boys were reported as overweight (12).

Overweight can be assessed in several ways. Every strategy has benefits and drawbacks, and the suitability and scientific acceptability of each approach will vary depending on the circum- stances. Body Mass Index (BMI) is a method of utilizing an individual's height and weight to determine whether they are underweight, normal, overweight, or obese categories (13). Obesity in adolescents is commonly defined by body mass index (BMI) (14). Obesity increases the likelihood of cardiovascular disease (CVD) by affecting metabolism and hemodynamic (15) and that childhood obesity is a multisystemic disorder with corresponding comorbidities (16).

Assessing cardiovascular fitness in overweight adolescents by employing Body Mass Index. The calculation of the BMI is as follows:

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

To calculate the Body Mass Index (BMI), first measure the weight in kilograms and then convert the height from centimeters to meters using the formula (cm = m / 100) (17). Based on the new consensus recommendation for India, the obesity was classified by ASIAN Classification (18).

Table 1: BMI Classification

BMI (kg/m^2)	**Classification**
< 18.5	Underweight
18.5 – 22.9	Normal
23.0 – 24.9	Overweight
≥ 25.0	Obese

Few step tests offer formulas for estimating (VO_2max), de- spite the fact that there are numerous options for assessing cardiorespiratory fitness. This study includes only the step test method that utilizes prediction equations. Although these step test protocols exhibit submaximal characteristics, individuals who are obese, short, or inactive may need energy expenditures that exceed moderate degree of intensity exertion and can even attain (VO_2max) values (Hansen et al. 2011). Step tests are easy to administer to a diverse range of subjects and do not necessitate expensive or complicated equipment, making them some of the most commonly employed field tests for determining (VO_2max). A significant field test is the Queens College Step Test (QCT), which is accessible, affordable, and does not require any equipment. This test was developed by McArdle et al. (1972) and furthered by Molanouri Shamsi et al. The Queens College Step Test (QCT) serves as a submaximal exercise test aimed at evaluating cardiorespiratory fitness. This assessment can also be employed to evaluate maximal oxy- gen consumption (VO_2max). VO_2max serves as a globally recognized benchmark for measuring cardiorespiratory fitness (Shepard 1968) (19).

The peak validity coefficient r = -0.76 was determined when (VO_2max) was correlated with the first 15 seconds of recovery heart rate from the Queens College step test. As a consequence, the recovery heart rate measured through the Queens College step test reflects about 58% of the differences in aerobic capacity (20). According to a few articles, exercise is a crucial factor for day-to-day routine to maintain a healthy lifestyle. So, there are two methods that can help to reduce adipose tissue (body fat), which are (1) dietary adjustment and (2) exercise. Therefore, reducing excess adipose tissue and obesity can be aided by boosting energy expenditure. Physical activity (PA) refers to the movements of the body that are produced by skeletal muscles and require energy expenditure. Consistent and adequate engagement in physical activity is vital for promoting overall health. Being overweight and other metabolic and physical activity factors are negatively correlated with physical activity participation. vascular conditions. Due to insufficient levels of physical activity, childhood and adolescent obesity has become a global problem. Through adaptation to the heart and vascular system, physical activity can significantly enhance cardiovascular function. Consistent exercise fosters physiological cardiac hypertrophy while decreasing blood pressure, atherogenic markers, and resting heart rate (21).

Improvement in endothelial function is observed by increasing the bioavailability of nitric oxide through regular physical exercise; cardiovascular risk has been reduced using aerobic exercise (22). Aerobic exercise is a key factor in improving physical stamina and is essential in various athletic disciplines. Anaerobic energy contributes to the restoration of muscle pH and the utilization of glycogen during periods of overload, while an enhancement in aerobic capacity further im- proves the ability to transport oxygen (23). The aerobic capacity, which is determined by the skeletal muscles' ability to utilize oxygen and the capability of the cardiorespiratory system to deliver it, is the most effective way to engage in aerobic activities. The primary measure of aerobic capacity, peak oxy- gen consumption (VO_2), can be evaluated using graded exercise ergometry, treadmill protocols, or mathematical computations. The study by Vaitkevicius et al., it was revealed that enhanced physical fitness is associated with a reduction in arterial stiffness (24).

Aerobic metabolism is essential for obtaining energy in the form of adenosine triphosphate (ATP) from amino acids, carbohydrates, and fatty acids by muscle groups stimulated by aerobic exercise. The enhancement in mitochondrial energy utilization is based on an increase in the density and size of mitochondria, improved capillary supply within muscle fibers, and elevated levels of oxidative enzymes. Steady-state cardio, or aerobic exercise, is carried out at a steady, slow-to-moderate pace, engaging slow-twitch muscle fibers, which is excellent for cardiovascular conditioning and enhances muscle endurance. When exercising, the body uses more energy than before, and the circulatory system must adapt quickly to meet this demand. This includes removing waste products from metabolism, including lactic acid and carbon dioxide, and dissipating more heat. Every bodily system, including metabolic and cardiovascular ones, works to cause a change in body metabolism. A sufficient blood supply is necessary for both cellular respiration and the transportation of oxygen, which is then used by the contracting muscle's mitochondria. Aerobic exercise has some benefits, but its impact is limited in terms of frequency and amount. A recent study found that exercising for 1 to 2.4 hours, 2 to 3 times a week, is the ideal amount for improving health. Any more exercise than that does not provide additional benefits in terms of reducing mortality risk. The concept of aerobic capacity pertains to the ability of significant skeletal muscle groups to adjust to workload by employing energy sourced from aerobic metabolism. (VO_2max) is a reliable indicator of aerobic capacity, representing the physiological interplay among pulmonary, cardiovascular, and neuromuscular functions (25).

Plyometric exercise is a powerful weight-loss supplement that increases strength and endurance, boosts metabolism, and aids in calorie burning. Therefore, this workout will help you lose weight. Pythian or plyo, which means to grow, and metric, which means to measure (to increase the measurement), are the Greek terms from which the word plyometric is formed (26).

Plyometric training (PT) has been shown to be quite effective in the context of children's fitness. The study can be conducted on both sexes. Multi-joint movements are involved in plyometric training (i.e., skipping, leaping, hopping, etc.). Plyometric training engages the stretch-shortening cycle (SSC), in which muscles are quickly stretched (eccentric phase) followed by an immediate shortening (concentric phase). Researchers concur that plyometric training is suitable for youth, as it offers a safe and effective method for conditioning, and thus should be incorporated into youth health and fitness programs. Likewise, health benefits have been shown in studies, benefiting the vertical and horizontal jumps, which improved notably, change of direction of speed, balancing, running speed, agility, and endurance adaptation amongst the children. To enhance children's motor skills, including running, throwing, hopping, kicking, and other frequently engaged recreational and play activities, PT can serve as a highly effective approach, as it significantly aids in producing dynamic movements and enhanced strength in muscles and bones. The performance of plyometric training is more over hard surfaces compared to compliant surfaces such as sand, as it reduces the elastic bound force and, as a result, stores the generated muscle energy (27).

Plyometric training employs the most authentic form of the body's natural reaction to the quick elongation of muscles, commonly referred to as the stretch-shortening cycle or myotatic re- flex. Muscles that undergo rapid stretching prior to contraction will contract more quickly and forcefully, leading to beneficial adaptations for strength, as demonstrated by research. Since the 1960s, a system of exercises to improve performance has been actively used, known as" plyometric." In plyometric exercises, force is generated by the stretch reflex, also known as the myotatic reflex, which is an important mechanism for the stretch-shortening cycle. The proportion of force in plyometric movement is the basic elastic energy produced by the elastic nature of muscles and tendons; a considerable amount of force is generated through the rapid recruitment of muscle fibers in the stretch response. The study has shown that when muscles are rapidly lengthened, slow-twitch muscle fibers are deactivated and fast-twitch muscle fibers are selectively activated (28).

After reviewing the literatures, there are limited study regarding cardiovascular fitness in overweight adolescents, and there is a lack of study to find the comparative effect of plyometric training and aerobic exercise training in overweight adolescents. Hence, there is the need to conduct this study.

This study seeks to analyze the effects of plyometric training as opposed to aerobic exercise training on body mass index and cardiovascular fitness in overweight adolescents who are students in Anand city (Gujarat). The objective of this research is to identify and compare the effectiveness of plyometric and aerobic exercise training in decreasing BMI and boosting cardio- vascular fitness in overweight adolescents enrolled in schools in Anand City.

The hypotheses proposed for the study are as follows:

The null hypothesis (H0) asserts that there is no significant difference in the effects of plyometric training and aerobic exercise training on the BMI and cardiovascular fitness of over- weight school-going adolescents in Anand city.

The alternative hypotheses consist of (H1) which posits that a significant difference exists between the two training methods, (H2) which suggests that plyometric training is more effective, and (H3) which suggests that aerobic exercise training is more effective in enhancing BMI and cardiovascular fitness among these adolescents.

MATERIALS AND METHODOLOGY

This comparative study was performed in Anand city, Gujarat, and involved overweight adolescents, including both boys and girls. 30 students were selected through a convenient sampling method and were evenly allocated into two groups, comprising 15 participants in each group. Group A participated in plyometric training exercises, while Group B underwent aerobic training exercises. The intervention was carried out over a treatment duration of four weeks.

This study's inclusion criteria specified adolescents aged 10 to 19 years who were identified as overweight, with a Body Mass Index (BMI) that ranged from 23 to 24.9 kg/m2. Both boys and girls students were included in the study. Participants were excluded if they had recent musculoskeletal injuries, such as fractures, a history of severe cardiovascular or neurological conditions, or metabolic diseases, including hypertension and diabetes. In addition, students who were unwilling to participate were also excluded from the study.

Measurement procedure

It is an experimental study which consist of 30 participants who are overweight and comes in the inclusion criteria of adolescent. The individuals who met the inclusion criteria were included. They were requested to take part in the study and the complete details of the procedure, and the intervention were explained to them. The participants were briefed about the nature and duration of the study and those unwilling to participate were excluded from the same. They were ensured that their per- sonal details will remain classified, and their identities would not be revealed in the study, and it will only be used for the re- search purpose. They were then divided into two groups: Plyometric exercise and Aerobic exercise. Two consent forms were given to the participants namely personal consent and parental consent form and a detailed assessment was carried out.

The 30 participants were subsequently assigned at random to two groups, with the training duration spanning 6 weeks, comprising 3 sessions per week on non-consecutive days, resulting in a total of 18 sessions for each participant, each lasting 45 minutes, with incremental progress each week.

Pre and post outcomes were measured by using two outcome measures namely:

BMI: (Body Mass Index)

Body Mass Index refers to the ratio of a person's weight to the square of their height. The validity of the BMI as an indicator of adiposity in pediatric populations has been better understood due to two recent studies. BMI -measured % fat in boys and girls aged 5 to 19 varied from 0.79 to 0.83, and age considerably influenced the regression model, as demonstrated by Pietro Belli et al. 5 in this edition of the journal (35).

QCT: (Queens College Step Test)

The Queen's College Step Test (QCT) is a submaximal exercise test utilized to assess cardiorespiratory fitness. This assessment can also estimate maximal oxygen consumption (VO_2max), which is a globally accepted reference standard for determining cardiorespiratory fitness.

Pre-test specifications and measurements: Describing the test's process and signing the consent form. Participant should take 3-5 minutes to rest. Participants resting heart rate must be taken after the rest period.

Test procedure:

In this test, the steps of participants at a rate of 22 steps · min−1 (females) or 24 steps · min−1 (males) for 3 minutes and the bench height is 16.25 in (41.3 cm) which has been devised by McArdle and colleagues (1972), Instruct the participants to remain standing after the exercise. After a 5-second pause, take a 15-second heart rate (HR) count. To convert this count to beats per minute (bpm), multiply by 4. To estimate VO_2max in ml · kg−1 · min−1:

Men: VO_2max = 111.33 − (0.42 × HR in bpm)
Women: VO_2max = 65.81 − (0.1847 × HR in bpm)
The standard error of prediction for these equations is ±16%. The validity of step tests is generally lower than that of distance run tests; however, the effectiveness of step tests in assessing cardiorespiratory fitness is highly dependent on factors such as obesity, height, fitness level, and the precise measurement of heart rate (HR) (36).

Exercise protocol

Warm up session include:10 minutes, with 10 repetitions of each exercise and stretching with 30 seconds hold-3 repetitions.

Group A: Plyometric exercise: The protocol was given for 3 non-consecutive days (2 sets and 6 repetitions) for a week for 4 weeks. The exercises include lateral jumps on a single leg, side-to-side ankle hops, squat jacks, standing long jumps, lateral cone hops, standing jump and reach, single leg bounding, front cone hops, double cone hops, and alternating jump lunges.

Group B: Aerobic exercise: The protocol was provided for three non-consecutive days each week over a duration of four weeks. Frequency – 4 days per week for 4 weeks Intensity – according to karvonen's formula (Target heart rate = ((MHR – RHR) × Training %) + RHR) Time – 45 minutes Type – continuous aerobic training (High knees, jumping jacks, huffles, frog jumps, mountain climbers, squat with shoulder punch, star jumps, side crunches, half squat and stepper exercise).Cool down session includes 10 minutes, with 10 repetitions of each exercise and stretching with 30 seconds hold-3 repetitions.

RESULTS

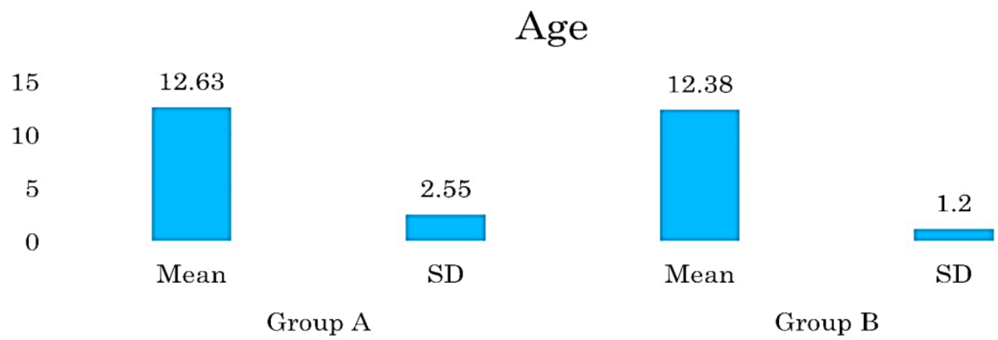
In this research, 30 participants aged between 10 and 19 years were selected and split into two groups. Group A underwent Plyometric exercise training, while Group B engaged in Aerobic exercise training. Each group consisted of 15 participants, and they completed 16 sessions consistently. Data analysis was performed using SPSS (Statistical Package for the Social Sciences) version 16. A paired t-test was utilized to analyze pre and post outcomes within each group, and an unpaired t-test was applied for comparisons between the groups. The results obtained from both groups are as follows: A comparison between Group A and Group B was conducted using an independent sample t-test. A significance level of 5% was established, with a p-value of less than 0.05 deemed statistically significant.

Table 2: Age distribution of the participants

Age	Group A	Group B	p-value
Mean ± SD	12.63 ± 2.55	12.38 ± 1.20	0.72

Note: The p-value of 0.72 indicates that there is no statistically significant difference in the age distributions of the two groups, as p is greater than 0.05.

Figure 1: Bar chart showing mean age of Group A and B



Note: For between-group comparisons, an independent sample t- test (unpaired t-test) was applied. There was no significant difference in BMI between both groups at pre-training and post-training (p = 0.05).

Table 3: Comparison of BMI Between Group A and Group B

Variables	Group A	Group B	p-value
BMI pre-training	23.83 ± 0.59	23.82 ± 0.39	0.93
BMI post-training	23.58 ± 0.44	23.66 ± 0.41	0.62
Change in BMI	0.25 ± 0.34	0.16 ± 0.08	0.31

Figure 2: Bar chart showing Pre and Post values of BMI in Group A and Group B

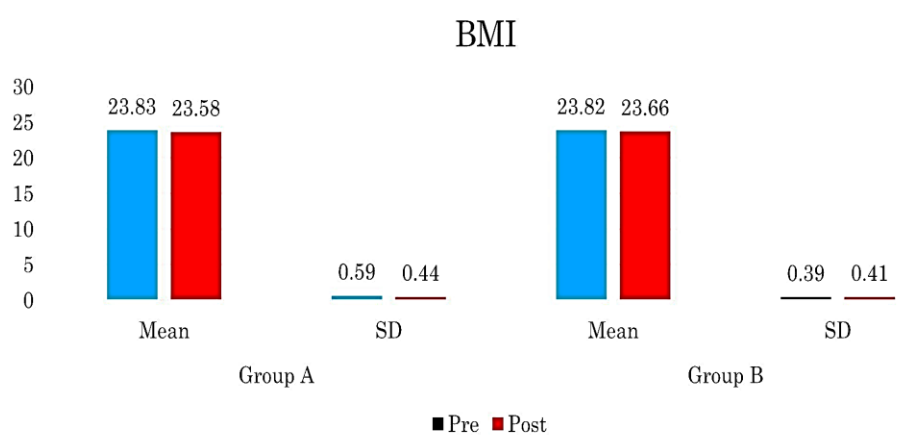


Table 4: Comparison of QCT Between Group A and Group B

Variables	Group A	Group B	p-value
QCT pre-training	64.14 ± 14.29	62.59 ± 13.72	0.75
QCT post-training	85.38 ± 15.40	76.51 ± 10.52	0.06

Change in QCT	21.24 ± 5.32	13.92 ± 5.48	0.001

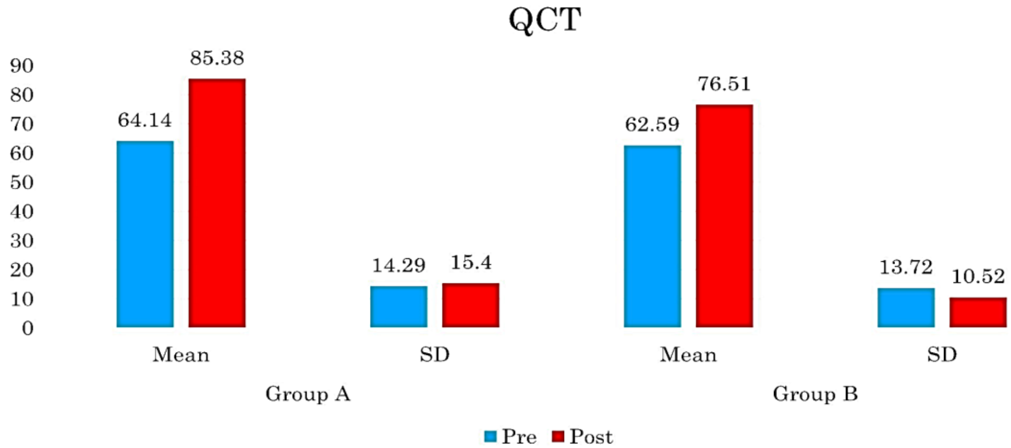


Figure 3: Bar chart showing Pre and Post values of QCT in Group A and Group B

Note: Independent sample t-test (Unpaired t-test) was used for between-group comparison. There was no significant difference in BMI between both groups at pre-training and post-training. However, the difference (post and pre-training) in QCT between both the groups is statistically significant ($p = 0.05$), indicating that group A has significantly higher QCT than group B.

Table 5: Within-Group A Comparison of BMI and QCT Pre- and Post-Training

Variable	Pre-training	Post-training	p-value
BMI	23.83 ± 0.59	23.58 ± 0.44	0.001
QCT	64.14 ± 14.29	85.38 ± 15.40	0.001

Note: Paired sample t-test was used for within-group comparisons. In group A, BMI is significantly decreased from pre to post ($p < 0.005$) and QCT is significantly increased ($p < 0.05$)

Table 6: Within-Group B Comparison of BMI and QCT Pre- and Post-Training

Variable	Pre-training	Post-training	p-value
BMI	23.82 ± 0.39	23.66 ± 0.41	0.001
QCT	62.59 ± 13.72	76.51 ± 10.52	0.001

Note: Paired sample t-test was used for within-group comparisons.

Similarly, in group B, BMI decreases significantly from pre to post ($p < 0.005$), while QCT increases significantly ($p < 0.05$).

DISCUSSION

The current research sought to examine the impacts of plyometric exercise training versus aerobic exercise training on Body Mass Index (BMI) and cardiovascular fitness in overweight school-going adolescents. Group A underwent a plyometric training regimen for four weeks, consisting of four sessions per week on non-consecutive days (a total of 16 sessions), while Group B received aerobic exercise training with the same frequency and duration.

The outcomes demonstrated a significant improvement in cardio- vascular fitness in both groups after the 16-session intervention, with a comparatively greater improvement observed in the plyometric exercise group. These findings led to the rejection of the null hypothesis, which assumed no significant difference between the interventions. Instead, the alternative hypothesis was accepted, affirming that plyometric training is more effective than aerobic exercise in improving BMI and cardiovascular fitness in overweight adolescents.

Individual-level analysis revealed a marked improvement in cardiovascular fitness following plyometric training. Statistical analysis, conducted using SPSS version 16, showed a significant enhancement in the Queens College Step Test (QCT) mean scores from 21.24 ± 5.32 to 13.92 ± 5.48 ($p = 0.001$), indicating a substantial increase in VO_2max and cardiovascular efficiency. Correspondingly, the QCT score improved from 64.14 ± 14.29 to 85.38 ± 15.4 ($p < 0.001$). A statistically significant reduction in BMI was also observed, underscoring the efficacy of the plyometric intervention in improving body composition and cardiorespiratory performance.

The findings of the current study are supported by prior research. Hamza Marzouki et al. (2022) investigated the effect of surface- type plyometric training on physical fitness in school-aged children. Their randomized controlled trial, conducted over four weeks with thrice-weekly sessions, showed significant improvements in all physical performance variables ($p < 0.001$), regardless of surface type or sex. Their results emphasize that plyometric training contributes to health-related fitness improvements, especially in overweight or obese children (26).

Similarly, Lemessa Nugusa Dugasa (2022) conducted a 12-week intervention among U-17 male football trainees, reporting significant enhancements in BMI, power, and agility resulting from plyometric training (29). Avery D. Faigenbaum et al. (2007) It was found that boys aged 12 to 15 years who participated in a six-week combined plyometric and resistance training program experienced significantly greater improvements in fitness performance than those who engaged in resistance training alone (30).

In contrast, some studies have favored aerobic training for specific anthropometric outcomes. Srinivasan M et al. (2023) evaluated the effect of plyometric versus mat exercises on abdominal obesity among college students. Their six-week intervention revealed that the mat exercise group achieved greater reductions in BMI and waist-to-hip ratio than the plyometric group (31). Similarly, Jibi Paul et al. (2020) compared plyometric and high-intensity aerobic training in overweight college students and found a greater reduction in BMI and waist circumference in the aerobic group (32). A. Febin Jebaraj et al. (2016) also observed significant waist circumference reduction in adolescents following aerobic exercise compared to circuit training (33). Further- more, Dr. C. Robert Alexandar (2016) concluded that aerobic training was more effective than plyometric exercise and control conditions in reducing waist circumference among school-aged adolescents (34).

The findings of the present study align with previous research, demonstrating that reductions in BMI are indicative of significant improvements in body composition. In this study, BMI was used as a key parameter to classify participants as overweight for inclusion criteria. Although both plyometric and aerobic exercise interventions resulted in measurable improvements, the group that underwent plyometric training exhibited a significantly greater reduction in BMI and an improvement in cardiovascular fitness compared to the aerobic training group. This suggests that plyometric exercise may be a more effective modality for improving body composition and cardiovascular health among overweight adolescents.

CONCLUSION

The present study concludes that the plyometric and aerobic exercise interventions led to improvements in body mass composition and cardiovascular fitness among overweight school-going adolescents following a four-week training program. However, plyometric exercise training demonstrated a significantly greater enhancement in both parameters compared to aerobic training. These findings suggest that plyometric training may be more effective in improving health-related physical fitness in overweight adolescents and can be considered a vi- able strategy for early intervention in pediatric obesity and reduction of cardiovascular risk.

Implications and Contributions: This study provides evidence that plyometric training is more effective than aerobic exercise in improving BMI and cardiovascular health among adolescents, offering a promising strategy for obesity prevention in school programs.

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Author Contributions:
Dr. Sonia Bhatia: Conceptualization, Methodology, Validation, Formal Analysis, Investigation/Experiments, Data Curation, Visualization, Writing – Original Draft.
Dr. Sandipkumar Parekh: Writing – Review and Editing, Supervision, Technical Guidance, Final Approval of Manuscript.

List of Abbreviations:
QCT – Queens College Step Test
WHO – World Health Organization
CVD – Cardiovascular Disease
ATP – Adenosine Triphosphate
PT – Plyometric Training
HR – Heart Rate
SPSS – Statistical Package for the Social Sciences

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