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A Comparative Study on the Effect of Aerobic Exercises Vs Kuchipudi on Cardiorespiratory Fitness and Physical Activity Levels Among Young Females

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Abstract

Background: Cardiorespiratory fitness and physical activity are vital health determinants. While aerobic exercise is standard, Kuchipudi dance offers a culturally relevant alternative.

Aim: To compare Aerobic Exercise and Kuchipudi Dance effects on cardiorespiratory fitness and physical activity in young females.

Methodology: An experimental study of 40 healthy females (18–25 years) allocated to Aerobic Exercise (Group A, n=20) or Kuchipudi (Group B, n=20) for 12 weeks. Cardiorespiratory fitness (VO_2 peak via Cooper's 12-Minute Walk Test) and physical activity (IPAQ) were assessed at baseline, 6, and 12 weeks. Data were analyzed using Mixed Repeated Measures ANOVA.

Results: Both groups improved significantly ($p<0.001$). VO_2 peak improved from 30.22 to 35.93 ml/kg/min (Group A) and 30.55 to 39.40 ml/kg/min (Group B). IPAQ scores rose from 1587.50 to 2490.00 MET-min/week (Group A) and 1710.00 to 3031.45 MET-min/week (Group B). Group B showed significantly greater improvements ($p<0.001$).

Conclusion: Kuchipudi Dance is a superior modality for enhancing fitness and activity levels in young females compared to conventional aerobic exercise.

Keywords: Aerobic Exercise, Kuchipudi Dance, Cardiorespiratory Fitness, VO_2 Peak, Physical Activity, IPAQ, Cooper's 12-Minute Walk Test, Young Females.

Introduction

Physical activity is one of the most important determinants of health throughout the lifespan. It encompasses any bodily movement produced by skeletal muscles that results in energy expenditure above resting levels. Physical activity includes activities performed during occupation, transportation, household tasks, recreation, structured exercise, and sports. Regular participation in physical activity is fundamental for maintaining cardiovascular, respiratory, musculoskeletal, metabolic, and psychological health.

Conversely, insufficient physical activity has become one of the leading modifiable risk factors contributing to non-communicable diseases (NCDs) and premature mortality worldwide.[1–3]

The World Health Organization (WHO) recognizes physical inactivity as one of the leading global public health concerns. Insufficient physical activity contributes substantially to the increasing prevalence of cardiovascular diseases, type 2 diabetes mellitus, obesity, hypertension, osteoporosis, certain cancers, anxiety, and depression. Individuals who engage in regular moderate- to vigorous-intensity physical activity demonstrate better physical function, improved cardiorespiratory fitness, enhanced metabolic efficiency, and superior quality of life compared with sedentary individuals. Furthermore, regular physical activity has been shown to improve cognitive function, emotional well-being, sleep quality, and academic performance among young adults. [1,2,6,7]

Among the various components of health-related physical fitness, cardiorespiratory fitness (CRF) is considered one of the strongest predictors of overall health status and longevity. Cardiorespiratory fitness reflects the integrated ability of the cardiovascular and respiratory systems to deliver oxygen to the working skeletal muscles during sustained physical activity and the ability of the muscles to utilize oxygen efficiently for energy production. Higher levels of cardiorespiratory fitness are associated with lower risks of cardiovascular morbidity, metabolic disorders, and all-cause mortality, independent of other traditional risk factors. [4,5,8]

Young adulthood represents a critical stage for establishing lifelong health behaviors. During this period, individuals experience significant educational, occupational, and lifestyle transitions that frequently result in reduced participation in regular physical activity. Increased academic workload, prolonged screen time, sedentary learning environments, altered dietary habits, and psychosocial stress contribute to declining physical activity levels among university students, particularly females. These lifestyle changes may negatively influence cardiovascular health, aerobic capacity, body composition, and long-term functional fitness.[2,7,9]

According to the World Health Organization (WHO), nearly 1.8 billion adults, representing approximately 31% of the global adult population, do not achieve the recommended levels of physical activity. If this trend continues, the prevalence of physical inactivity is projected to increase to 35% by 2030, substantially increasing the global burden of cardiovascular and metabolic diseases. Physical inactivity alone accounts for an estimated 4–5 million preventable deaths annually, making it one of the most significant contributors to premature mortality worldwide. [9,2]

Regular participation in physical activity has consistently been associated with substantial reductions in the incidence of cardiovascular diseases, stroke, hypertension, obesity, osteoporosis, depression, anxiety, and all-cause mortality. Large epidemiological studies have demonstrated that individuals who maintain adequate physical activity exhibit superior cardiorespiratory fitness, improved metabolic health, enhanced endothelial function, and greater life expectancy than sedentary individuals. [4,5,7]

Young adults represent a particularly vulnerable population because the transition from adolescence to adulthood is frequently accompanied by marked reductions in habitual physical activity. Academic commitments, prolonged classroom attendance, increased use of digital devices, social media engagement, reduced recreational opportunities, and psychological stress collectively contribute to sedentary behaviour among university students. Female students often exhibit lower participation in moderate-to-vigorous physical activity than their male counterparts due to social, cultural, environmental, and behavioural factors. [2,10,11]

The burden of physical inactivity is also increasing rapidly in low- and middle-income countries, including India. Rapid urbanization, changing occupational patterns, mechanization of daily activities, and reduced participation in recreational exercise have resulted in declining physical activity levels among Indian adults. Recent national surveys indicate that a substantial proportion of Indian adults fail to meet the minimum recommended levels of physical activity required to maintain optimal cardiovascular health. Physical inactivity has therefore become an important public health concern in India, contributing significantly to the increasing prevalence of obesity, diabetes mellitus, hypertension, coronary artery disease, and other lifestyle-related disorders. [12,13,1.]

Among Indian women, particularly young adult females, inadequate physical activity is influenced by multiple factors, including academic demands, limited opportunities for structured exercise, sociocultural expectations, safety concerns, and insufficient awareness regarding the long-term health benefits of regular physical activity. Reduced participation in structured exercise programmes during early adulthood may adversely affect cardiorespiratory fitness, muscular endurance, bone health, body composition, and psychological well-being, thereby increasing future susceptibility to chronic diseases. [12,13,1,3]

Recognizing the growing burden of physical inactivity, the World Health Organization recommends that adults aged 18–64 years should accumulate at least 150–300 minutes of moderate-intensity aerobic physical activity, or 75–150 minutes of vigorous-intensity aerobic physical activity, or an equivalent combination each week. In addition, muscle-strengthening activities involving all major muscle groups are recommended on at least two days per week, while prolonged sedentary behaviour should be minimized whenever possible. These recommendations have also been endorsed by the American College of Sports Medicine (ACSM) as effective strategies for improving cardiovascular health, enhancing cardiorespiratory fitness, and reducing the risk of chronic diseases. [1–3,9]

Anatomy and physiology of the Cardiovascular and Respiratory Systems

The cardiorespiratory system is composed of the cardiovascular and respiratory systems, which function together to maintain tissue oxygenation, eliminate carbon dioxide, and preserve metabolic homeostasis. Efficient interaction between these systems is fundamental for sustaining physical activity, as oxygen delivery to the working skeletal muscles depends on the integrated performance of the heart, lungs, blood vessels, and respiratory muscles. During exercise, the oxygen demand of skeletal muscles increases several-fold, requiring coordinated physiological responses from both systems to maintain aerobic metabolism and delay fatigue. [15–17]

The cardiovascular system consists of the heart, arteries, capillaries, and veins, forming a closed circulatory network responsible for transporting oxygen, nutrients, hormones, and metabolic waste products throughout the body. The heart is a muscular organ located within the middle mediastinum and functions as a dual pump that maintains pulmonary and systemic circulation. Structurally, it comprises four chambers—right atrium, right ventricle, left atrium, and left ventricle—which work synchronously to ensure unidirectional blood flow through the pulmonary and systemic circulations. Cardiac valves, including the tricuspid, pulmonary, mitral, and aortic valves, prevent retrograde blood flow and maintain efficient cardiac output. [15,16]

The lungs are paired organs enclosed within the thoracic cavity and covered by visceral pleura, while the thoracic wall is lined by parietal pleura. Between these layers lies the pleural cavity containing a thin film of pleural fluid that minimizes friction and facilitates smooth expansion of the lungs during respiration. The right lung consists of three lobes, whereas the left lung contains two lobes to accommodate the

position of the heart. [17,18] Respiration is primarily driven by the diaphragm, which is the principal inspiratory muscle. During inspiration, contraction of the diaphragm and external intercostal muscles increases thoracic volume, generating negative intrathoracic pressure that allows air to enter the lungs. Expiration at rest is largely passive and occurs through elastic recoil of the lungs and chest wall; however, during vigorous exercise, accessory inspiratory muscles and abdominal muscles become increasingly active to augment ventilation. [17,18,19]

The cardiovascular and respiratory systems function as an integrated oxygen transport pathway. Oxygen enters the alveoli during inspiration, diffuses into pulmonary capillary blood, binds to haemoglobin, and is transported to peripheral tissues through systemic circulation. Simultaneously, carbon dioxide produced during cellular metabolism is transported back to the lungs, where it diffuses into the alveoli and is eliminated during expiration. During physical exercise, increases in heart rate, stroke volume, pulmonary ventilation, and skeletal muscle blood flow collectively enhance oxygen delivery and carbon dioxide removal, enabling sustained aerobic energy production. The efficiency of this integrated system forms the physiological basis of cardiorespiratory fitness, which is central to the present study. [16-19]

According to the Fick Principle, oxygen uptake (VO_2) depends on the volume of blood delivered to the tissues and the amount of oxygen extracted by the working muscles. Improvements in either cardiac output or peripheral oxygen extraction increase aerobic capacity and enhance exercise performance. [3,20-22]

Maximum oxygen uptake (VO_2 peak) is regarded as the gold-standard indicator of cardiorespiratory fitness because it reflects the highest rate at which oxygen can be transported, delivered, and utilized during maximal exercise. VO_2 peak is determined by central factors such as cardiac output and pulmonary function, as well as peripheral factors including skeletal muscle capillary density, mitochondrial content, oxidative enzyme activity, and muscle fibre characteristics. Individuals with higher VO_2peak values generally demonstrate superior endurance capacity, greater functional performance, and lower risks of cardiovascular disease and premature mortality. [19,3,24]

During progressive aerobic exercise, oxygen consumption initially increases linearly with exercise intensity until reaching maximal aerobic capacity. Beyond this point, additional energy requirements are met predominantly through anaerobic metabolism, resulting in lactate accumulation and earlier onset of fatigue. Regular endurance training delays lactate accumulation by improving mitochondrial oxidative capacity, increasing capillary density, and enhancing aerobic enzyme activity, thereby enabling sustained physical activity at higher intensities. [21,23,24]

Aerobic Exercise and Kuchipudi Dance

Aerobic exercise is widely recognized as one of the most effective non-pharmacological interventions for improving cardiovascular health, pulmonary function, and overall physical fitness. It is defined as continuous, rhythmic physical activity involving large skeletal muscle groups, performed for a prolonged duration at an intensity sufficient to stimulate aerobic metabolism. During aerobic exercise, oxygen consumption increases proportionally with exercise intensity, enabling the body to generate adenosine triphosphate (ATP) primarily through oxidative phosphorylation. Consequently, aerobic exercise has become the cornerstone of health promotion, disease prevention, and cardiopulmonary rehabilitation programmes worldwide. [1–5]

The American College of Sports Medicine (ACSM) recommends that healthy adults should participate in at least 150–300 minutes of moderate-intensity aerobic exercise or 75–150 minutes of vigorous-intensity aerobic exercise each week, supplemented with muscle-strengthening activities on two or more days per

week. Similarly, the World Health Organization (WHO) advocates regular physical activity to reduce the risk of cardiovascular diseases, diabetes mellitus, obesity, hypertension, certain cancers, and premature mortality while improving mental well-being and quality of life.[1–3]

Aerobic exercise induces both acute physiological responses and long-term training adaptations within the cardiovascular and respiratory systems. During exercise, heart rate, stroke volume, cardiac output, pulmonary ventilation, and skeletal muscle blood flow increase to meet the elevated metabolic demands of the working muscles. Repeated aerobic training results in favourable adaptations, including increased myocardial efficiency, improved endothelial function, enhanced capillary density, greater mitochondrial biogenesis, increased oxidative enzyme activity, and improved autonomic regulation. These adaptations collectively enhance oxygen transport, improve maximal oxygen uptake (VO_2 peak), delay fatigue, and increase functional exercise capacity. [4–8]

Cardiorespiratory fitness is regarded as one of the strongest predictors of cardiovascular health and all-cause mortality. Improvements in cardiorespiratory fitness following aerobic training are associated with reduced resting heart rate, improved blood pressure regulation, enhanced insulin sensitivity, better lipid metabolism, and reduced risk of future cardiovascular disease. Consequently, aerobic exercise forms the foundation of contemporary cardiac rehabilitation, pulmonary rehabilitation, preventive cardiology, and lifestyle medicine.[4,5,8,9]

Exercise prescription should follow the FITT principle, which includes Frequency, Intensity, Time, and Type of exercise. Appropriate manipulation of these components ensures safe progression, adequate training stimulus, and optimal physiological adaptations while minimizing the risk of injury or overtraining. For healthy young adults, moderate-intensity aerobic exercise performed three to five days per week for 30–60 minutes per session has consistently been shown to improve cardiorespiratory fitness and physical activity levels.[2,3,6]

While conventional aerobic exercise remains highly effective, maintaining long-term adherence represents a major challenge, particularly among young adults. Repetitive exercise routines may reduce motivation and compliance over time. Consequently, there is growing interest in identifying enjoyable, culturally acceptable, and sustainable forms of physical activity capable of producing comparable physiological benefits while promoting greater exercise adherence.[01,9]

Kuchipudi is one of the eight classical dance forms officially recognized by the Sangeet Natak Akademi and originated in the village of Kuchipudi, Andhra Pradesh, India. Traditionally developed as a dance-drama, Kuchipudi integrates rhythmic footwork, dynamic lower-limb movements, expressive hand gestures (Mudras), body postures, facial expressions (Abhinaya), and coordinated whole-body movements performed in synchrony with music. Although primarily regarded as a performing art, Kuchipudi also represents a structured form of moderate-to-vigorous physical activity requiring considerable cardiovascular endurance, muscular strength, flexibility, balance, agility, coordination, and neuromuscular control.[2,4,5]

From a biomechanical perspective, Kuchipudi involves repeated squatting positions (Araimandi), multidirectional stepping, rapid changes in direction, jumping, turning, dynamic weight transfer, and sustained postural control. These movements recruit large muscle groups of the lower limbs, trunk, and upper extremities while simultaneously challenging balance and motor coordination. Continuous rhythmic movement performed over prolonged durations substantially increases energy expenditure and oxygen consumption, thereby providing an aerobic training stimulus.[4,5,7]

Physiologically, regular Kuchipudi practice may induce cardiovascular adaptations comparable to conventional aerobic exercise. Sustained rhythmic movements increase heart rate, stroke volume, pulmonary ventilation, skeletal muscle perfusion, and oxygen extraction. Repeated practice also improves muscular endurance, movement efficiency, postural stability, proprioception, and neuromuscular coordination. Emerging evidence suggests that structured dance programmes can significantly improve cardiorespiratory fitness, functional capacity, balance, body composition, psychological well-being, and quality of life across different age groups.[01,7,11,12]

An additional advantage of dance-based exercise is its high level of enjoyment and intrinsic motivation. Unlike traditional exercise programmes, dance combines physical activity with music, rhythm, creativity, emotional expression, and social interaction, factors that have been shown to improve exercise adherence and long-term participation. For young females, culturally familiar dance forms such as Kuchipudi may therefore represent an attractive alternative to conventional aerobic exercise while providing comparable physiological benefits.[1,10,11,12]

Despite increasing evidence supporting dance as a therapeutic exercise modality, relatively few studies have directly compared the effects of structured aerobic exercise and Kuchipudi dance on cardiorespiratory fitness and physical activity levels among healthy young females. Most existing studies have focused on balance, flexibility, musculoskeletal performance, or psychological outcomes, whereas evidence regarding the comparative effects of these interventions on aerobic capacity remains limited. Addressing this knowledge gap may contribute to the development of culturally appropriate, enjoyable, and evidence-based exercise programmes that enhance cardiorespiratory fitness and promote lifelong physical activity participation among young women. [1,2,11,12]

In recent years, there has been increasing scientific interest in utilizing dance-based physical activity as an alternative form of exercise. Dance combines aerobic conditioning with rhythm, coordination, flexibility, balance, cognitive engagement, and emotional expression, making it an enjoyable and sustainable mode of physical activity. Systematic reviews have reported that structured dance programmes can improve cardiovascular endurance, muscular fitness, balance, psychological well-being, and quality of life across different age groups.[10,11,13]

Among the Indian classical dance forms, Kuchipudi represents a unique combination of rhythmic lower-limb movements, dynamic postural transitions, multidirectional stepping patterns, coordinated upper-limb activities, expressive gestures, and continuous whole-body movement. These characteristics suggest that regular Kuchipudi practice may provide sufficient cardiovascular and metabolic stimulus to induce favourable cardiorespiratory adaptations. However, despite its physiological demands and increasing popularity, the scientific evidence evaluating the effects of Kuchipudi on objective measures of cardiorespiratory fitness remains limited.[12,13,14]

A review of the available literature indicates that most published studies involving classical Indian dance have primarily focused on flexibility, balance, musculoskeletal fitness, injury prevention, motor performance, or psychological outcomes. Comparatively fewer investigations have examined the influence of dance training on physiological parameters such as maximal oxygen uptake, aerobic capacity, or physical activity levels. Furthermore, very few studies have directly compared a structured aerobic exercise programme with a structured Kuchipudi dance programme using standardized measures of cardiorespiratory fitness in healthy young females.[10-14]

Therefore, the present study was designed to compare the effectiveness of Aerobic Exercise and Kuchipudi Dance in improving cardiorespiratory fitness and physical activity levels among healthy young females.

The findings of this study are expected to provide evidence regarding the potential role of culturally acceptable exercise interventions in enhancing cardiorespiratory health and promoting physically active lifestyles among young women. The outcomes may also assist physiotherapists in prescribing individualized, evidence-based, and enjoyable exercise programmes for health promotion and disease prevention.



Fig1. SAUSHTAVAM POSE(KUCHIPUDI)



Fig 2. ARAIMANDI POSE

Review of the literature

World Health Organization (2020) published the "WHO Guidelines on Physical Activity and Sedentary Behaviour." The primary objective of these guidelines was to provide evidence-based recommendations for physical activity across different age groups. After reviewing extensive scientific evidence, the WHO

recommended that healthy adults should perform at least 150–300 minutes of moderate-intensity or 75–150 minutes of vigorous-intensity aerobic physical activity per week to obtain substantial health benefits. The report concluded that regular physical activity significantly improves cardiorespiratory fitness, muscular strength, metabolic health, and psychological well-being while reducing the risk of cardiovascular disease, obesity, diabetes mellitus, and premature mortality. These recommendations provide the scientific foundation for promoting structured exercise programmes among healthy young adults.[1]

Ross et al. (2016) conducted a scientific statement titled "Importance of Assessing Cardiorespiratory Fitness in Clinical Practice: A Case for Fitness as a Clinical Vital Sign." The authors reviewed evidence demonstrating that cardiorespiratory fitness is one of the strongest independent predictors of cardiovascular morbidity and mortality. They recommended incorporating routine assessment of cardiorespiratory fitness into clinical practice irrespective of age or sex. The review highlighted that improving cardiorespiratory fitness through structured exercise significantly reduces future cardiovascular risk. Although the study did not specifically investigate young females, its recommendations strongly support routine assessment and promotion of cardiorespiratory fitness in this population.[4]

Warburton and Bredin (2017) conducted a systematic review titled "Health Benefits of Physical Activity: A Systematic Review of Current Evidence." The aim of the review was to evaluate the effects of regular physical activity on overall health. The authors analysed evidence from multiple clinical and epidemiological studies and reported that regular physical activity significantly improves cardiovascular function, pulmonary efficiency, metabolic regulation, musculoskeletal health, and psychological well-being. The review concluded that physical inactivity is one of the leading modifiable risk factors for chronic diseases and emphasized that participation in regular physical activity is essential for disease prevention and health promotion.[6]

Myers et al. (2021) conducted a review titled "New American Heart Association Clinical Recommendations for Cardiorespiratory Fitness." The objective of the review was to summarize contemporary evidence regarding the clinical importance of cardiorespiratory fitness. The authors concluded that CRF should be considered an essential health indicator because individuals with higher fitness levels have a substantially lower risk of cardiovascular disease and premature mortality. The review further recommended incorporating routine assessment of CRF into healthcare practice and promoting structured physical activity to improve cardiovascular health. These findings reinforce the importance of exercise-based interventions aimed at enhancing cardiorespiratory fitness[5]

Lavie et al. (2015) conducted a review titled "Exercise and the Cardiovascular System: Clinical Science and Cardiovascular Outcomes." The objective of the review was to summarize the physiological and clinical effects of exercise on cardiovascular health. The authors analysed evidence from epidemiological studies, randomized controlled trials, and clinical investigations evaluating different exercise interventions. The review demonstrated that regular aerobic exercise significantly improves endothelial function, myocardial efficiency, autonomic balance, exercise tolerance, and overall cardiovascular performance. Furthermore, regular participation in aerobic exercise reduced the incidence of cardiovascular diseases and all-cause mortality. The authors concluded that aerobic exercise should be considered an essential component of preventive and rehabilitative healthcare. However, the review mainly emphasized conventional exercise modalities without evaluating traditional dance-based interventions such as Kuchipudi[21]

Kenney et al. (2020) in the textbook "Physiology of Sport and Exercise" comprehensively described the physiological adaptations associated with regular aerobic training. The authors explained that endurance exercise increases stroke volume, maximal cardiac output, pulmonary ventilation, skeletal muscle capillary density, mitochondrial content, and oxidative enzyme activity. These adaptations improve oxygen delivery to working muscles and delay the onset of fatigue during prolonged physical activity. The authors further reported that improvements in aerobic fitness are directly related to the frequency, duration, and intensity of exercise performed. Their findings provide a strong physiological basis for using aerobic exercise to improve cardiorespiratory fitness among healthy young adults.[25]

Powers and Howley (2023) presented detailed evidence in "Exercise Physiology: Theory and Application to Fitness and Performance." The authors reviewed the mechanisms through which aerobic exercise enhances cardiovascular and metabolic function. Regular aerobic training was shown to increase mitochondrial biogenesis, improve fat oxidation, enhance skeletal muscle efficiency, and reduce lactate accumulation during exercise. These physiological changes collectively improve exercise performance and increase maximal oxygen uptake (VO_2 peak). The authors concluded that continuous aerobic exercise remains the gold standard for improving cardiorespiratory endurance in healthy individuals.[27]

Bassett and Howley (2000) conducted a review titled "Limiting Factors for Maximum Oxygen Uptake and Determinants of Endurance Performance." The purpose of the study was to identify the physiological factors influencing maximal oxygen uptake. The review demonstrated that cardiac output, pulmonary diffusion capacity, haemoglobin concentration, skeletal muscle blood flow, and mitochondrial oxidative capacity are the principal determinants of VO_2 peak. The authors emphasized that structured aerobic exercise positively influences each of these determinants, thereby improving aerobic performance and endurance capacity. Their findings continue to serve as the physiological basis for exercise prescription aimed at enhancing cardiorespiratory fitness.[29]

Esteban-Cornejo et al. (2024) conducted a study titled "Role of Cardiorespiratory Fitness, Aerobic Exercise and Sports Participation in Female Cognition." The aim of the study was to investigate the influence of cardiorespiratory fitness, aerobic exercise, and sports participation on cognitive performance among females. The authors reviewed evidence demonstrating that regular participation in structured physical activities significantly improved cardiorespiratory fitness, executive function, memory, and overall health status. The study concluded that enjoyable and sustained participation in physical activities contributes to better physiological and cognitive outcomes. However, the review mainly focused on aerobic exercise and organized sports, while traditional dance forms such as Kuchipudi were not evaluated. The findings nevertheless suggest that culturally engaging physical activities capable of maintaining long-term participation may also improve cardiorespiratory fitness among young females.[7]

Ross et al. (2024) published an updated scientific statement titled "Importance of Cardiorespiratory Fitness in Clinical Practice: An Update." The authors reaffirmed that improvements in cardiorespiratory fitness can be achieved through regular participation in sustained physical activity irrespective of the exercise modality. The review emphasized that the physiological response to exercise depends primarily on the intensity and duration of activity rather than the specific type of exercise performed. This observation supports the possibility that structured dance programmes performed at moderate-to-vigorous intensity may produce physiological adaptations comparable to conventional aerobic exercise.[30]

Mintjens et al. (2020) conducted a systematic review titled "Association of Cardiorespiratory Fitness Levels During Youth with Health Risk Later in Life." The objective of the review was to investigate whether cardiorespiratory fitness during childhood and young adulthood influences future health

outcomes. The authors systematically analysed longitudinal studies involving healthy young populations and found that individuals with higher cardiorespiratory fitness had a significantly lower risk of cardiovascular disease, obesity, metabolic disorders, and premature mortality later in life. The review concluded that improving cardiorespiratory fitness during youth is essential for long-term health promotion and disease prevention. These findings highlight the importance of implementing effective exercise programmes during early adulthood.[8]

Guthold et al. (2024) conducted a pooled analysis titled "Worldwide Trends in Insufficient Physical Activity from 2001 to 2022." The study analysed nationally representative surveys from multiple countries to determine global trends in physical inactivity. The authors reported that insufficient physical activity remains highly prevalent worldwide, with females consistently demonstrating lower physical activity levels than males. Young women were identified as one of the most vulnerable populations due to increasing sedentary behaviour and declining participation in recreational exercise. The study emphasized the need for innovative and culturally acceptable interventions to improve physical activity levels among women.[9]

McNulty et al. (2020) conducted a systematic review and meta-analysis titled "The Effects of Menstrual Cycle Phase on Exercise Performance in Healthy Women." The objective of the study was to determine whether different phases of the menstrual cycle influence exercise performance in healthy females. The review analysed multiple studies involving physically active women and found that although minor physiological variations occur across the menstrual cycle, overall exercise performance and training adaptations remain relatively consistent in most healthy females. The authors concluded that women can safely participate in structured exercise programmes throughout the menstrual cycle with appropriate individualization when necessary. These findings support the feasibility of implementing aerobic exercise and dance-based interventions among healthy young females.[32]

The Health Benefits of Kuchipudi Dance evaluated the physical and psychological effects of practicing Kuchipudi dance as a form of physical activity. The target population included individuals practicing classical dance, particularly Kuchipudi dancers, within an age group of adolescents and young adults. Participants were generally healthy without clinical diagnoses. The duration of dance training ranged from several weeks to months depending on the program structure. The outcome measures included physical fitness levels, flexibility, balance, and psychological well-being. The study demonstrated that regular participation in Kuchipudi dance significantly improved both physical and mental health outcomes. The conclusion indicated that classical dance forms such as Kuchipudi can be considered an effective method for promoting overall fitness and well-being.[32]

Impact of Dance on Physical Fitness investigated the role of dance as a physical activity in improving fitness components among individuals. The target population included participants engaged in structured dance programs within an age group of adolescents and young adults. Participants were generally healthy without medical diagnoses. The duration of the dance intervention lasted several weeks. The outcome measures included muscular strength, flexibility, endurance, and physical activity levels. The results demonstrated that participation in dance significantly improved overall physical fitness components. The conclusion highlighted that dance-based exercise programs can effectively enhance physical fitness and promote an active lifestyle.[33]

A Comparative Study on Motor Performance and Body Composition Among Dancers and Athletes examined differences in physical fitness characteristics between dancers and athletes to understand the effectiveness of dance as a form of physical activity. The target population included trained dancers and

athletes, while the population consisted of physically active individuals engaged in structured training programs. The age group of participants ranged from late adolescence to young adulthood. The diagnosis involved assessment of baseline physical fitness and body composition parameters without the presence of clinical disease conditions. The duration of participation was based on regular training involvement over several months to years depending on the individual's experience level. The outcome measures included motor performance tests such as agility, balance, coordination, muscular strength, and body composition indices including body mass index (BMI) and body fat percentage. The study reported that dancers demonstrated comparable levels of physical fitness to athletes, indicating that classical dance training can provide sufficient physical activity to maintain good motor performance and body composition. The conclusion highlighted that structured dance programs can be considered an effective alternative to traditional sports activities for improving physical fitness and maintaining overall health among young individuals.[34]

Need of the study

Cardiorespiratory fitness (CRF) is recognized as one of the most important indicators of overall health and physical well-being. Higher levels of cardiorespiratory fitness are associated with reduced risk of cardiovascular diseases, metabolic disorders, obesity, and premature mortality, while lower levels are linked to adverse health outcomes throughout the lifespan. Evidence suggests that cardiorespiratory fitness attained during young adulthood plays a crucial role in determining future health status and disease risk. Therefore, improving CRF among young females is an important public health priority.[1–5]

In recent years, a decline in physical activity levels among young adults has become a growing concern due to increased sedentary behavior, academic demands, technological dependence, and lifestyle changes. Insufficient physical activity negatively affects cardiorespiratory fitness, physical function, and long-term health. Consequently, there is a need to identify effective, enjoyable, and sustainable forms of exercise that can improve physical activity participation and cardiorespiratory fitness among young females.[2,3,4]

Aerobic exercise has been widely recommended as an effective intervention for enhancing cardiorespiratory fitness, improving aerobic capacity, and increasing overall physical activity levels. Previous studies have demonstrated that structured aerobic exercise programs can significantly improve physical fitness, cardiovascular endurance, and health-related quality of life in women.[14,15] However, adherence to conventional exercise programs may be limited due to lack of motivation, monotony, or reduced long-term engagement.

Dance-based physical activities have emerged as alternative exercise modalities capable of producing significant physiological and psychological benefits. Dance combines rhythmic movement, coordination, balance, endurance, and cognitive engagement, making it a holistic form of physical activity. Recent systematic reviews have reported that dance interventions positively influence physical fitness, physical function, quality of life, and overall health outcomes.[9,10]

Kuchipudi, a classical dance form originating from Andhra Pradesh, involves continuous dynamic movements, rhythmic footwork, postural control, flexibility, coordination, and sustained muscular activity. These characteristics suggest that Kuchipudi may provide sufficient physiological stimulus to improve cardiorespiratory fitness and physical activity levels. Furthermore, dance-based exercise may promote greater enjoyment, cultural relevance, and long-term participation compared to traditional exercise programs.[6,8]

Studies evaluating Indian classical dancers have reported favorable aerobic capacity, motor performance, and physical fitness characteristics among trained dancers. Research comparing Bharatanatyam and Kuchipudi dancers has demonstrated that classical dance training contributes to improvements in aerobic fitness and VO_2 peak.[7] Additionally, investigations involving various dance forms have shown significant improvements in physical conditioning and health-related fitness parameters.[11,12,13]

Despite the growing evidence supporting dance as a form of physical activity, there is limited scientific literature directly comparing the effects of Kuchipudi dance and conventional aerobic exercise on cardiorespiratory fitness and physical activity levels among young females. Furthermore, very few studies have explored the potential of Kuchipudi as a culturally relevant exercise intervention in the South Indian population, particularly among young women.

Therefore, the present study was undertaken to compare the effects of a structured Aerobic Exercise Program and a structured Kuchipudi Dance Training Program on cardiorespiratory fitness and physical activity levels among young females. The findings of this study may contribute to the development of culturally acceptable, enjoyable, and effective exercise strategies for improving health-related fitness and promoting active lifestyles among young women.

Aim of the study

To compare the effects of aerobic exercise and kuchipudi dance on cardiorespiratory fitness and physical activity levels among young females.

Hypothesis of the study

Null Hypothesis (H_0):

There is no difference between Aerobic Exercise and Kuchipudi Dance in improving cardiorespiratory fitness and physical activity levels among young females.

Alternative Hypothesis (H_1):

There is a difference between Aerobic Exercise and Kuchipudi Dance in improving cardiorespiratory fitness and physical activity levels among young females

Objectives of the study

1. To evaluate the effect of a structured aerobic exercise program on cardiorespiratory fitness using cooper's 12minutes walk test among young females.
2. To evaluate the effect of a structured aerobic exercise program on physical activity levels using IPAQ for physical Activity among young females.
3. To evaluate the effect of a structured Kuchipudi dance program on cardiorespiratory fitness using Cooper's 12minutes walk test in young females.
4. To evaluate the effect of a structured Kuchipudi dance program on physical activity levels using IPAQ for physical Activity among young females.
5. To compare the effect of aerobic exercises vs Kuchipudi dance on cardiorespiratory fitness and physical activity levels among young females.

Materials and methodology

Materials:

The following materials will be used for conducting the study:

- Participant information sheet, Informed consent form
- Case record sheet, Pen and paper, Measuring tape, Marker cones
- Stopwatch, Digital weighing machine, Stadiometer/height measuring scale, Calculator
- Flat, well-ventilated, non-slippery surface floor, Comfortable exercise area
- Audio system/music support for aerobic dance sessions
- Kuchipudi practice space with adequate ventilation
- International Physical Activity Questionnaire (IPAQ-C)
- Cooper's 12-Minute Walk Test recording sheet

Methodology

Study setup:

- Sri Venkateswara College of Music and Dance TTD Tirupati.
- Sri Venkateswara institute of medical sciences, TTD Tirupati.

Study design: experimental study design

Sample size: 40

Sampling Method: Non random, purposive

Inclusion criteria [22]

- Female participants aged between 18–25 years apparently healthy young females
- Young females with BMI between 18.5 to 24.9 kg/m². [19,3]
- Young females with Moderate physical activity levels (5 or more days of any combination of moderate-intensity activity (including walking) for at least 30 minutes per day) according to IPAQ questionnaire.
- Females who are Willing to participate and provide informed consent.

Exclusion criteria [22]

- Females with BMI between < 18.5 – Underweight and ≥ 25 – Overweight/Obese Females with low physical activity levels according to IPAQ. [21,22]
- Individuals with any acute or chronic illness.
- Participants currently undergoing any fitness or dance training.
- Individuals with a history of cardiovascular or pulmonary disease, musculoskeletal disorders, endocrine disorders, nephrological disorders, neurological diseases.

Outcome measures:

Primary Outcome Measure

Cardiorespiratory fitness (VO_2 Peak) was assessed using: Cooper's 12-Minute Walk Test

Procedure:

- Participants was instructed to walk as fast as possible for 12 minutes on a flat marked surface
- Total distance covered in 12 minutes was measured in meters
- Encouragement was standardized for all participants
- The total distance covered was recorded

VO_2 peak was estimated using:

$$VO_2\,peak = (D - 504.9)/44.73$$

Where: D = Total distance covered in meters

The obtained value was expressed in: ml/kg/min

Secondary Outcome Measure

Physical activity levels was assessed using: International Physical Activity Questionnaire – Short Form (IPAQ-C)

Participants were divided into two groups:

Group A (20 participants) – Aerobic Exercise Group

Participants were underwent a structured aerobic dance exercise program.

Group B (20 participants) – Kuchipudi Dance Group

Participants were underwent a structured Kuchipudi dance training program.

Study procedure

The study was commenced after obtaining approval from the Institutional Ethics Committee of Sri Venkateswara Institute of Medical Sciences (SVIMS), Tirupati (IEC No. 1966). Permission to conduct the study was also obtained from the concerned authorities of Sri Venkateswara College of Music and Dance, TTD, Tirupati, and Sri Venkateswara Institute of Medical Sciences, Tirupati.

Participants were recruited using a purposive sampling technique. Apparently healthy young females between 18 and 25 years of age were screened for eligibility according to the predefined inclusion criteria. The purpose, objectives, methodology, benefits, and possible risks associated with the study were explained to all potential participants in a language they could easily understand. Those who expressed willingness to participate were enrolled in the study after obtaining written informed consent.

Following recruitment, demographic and anthropometric data were collected from all participants. Demographic information included age and relevant personal details, while anthropometric measurements included height and body weight. Body Mass Index (BMI) was calculated using the standard formula of weight in kilograms divided by height in meters square (kg/m^2). Only participants with a BMI ranging between 18.5 and 24.9 kg/m^2 and moderate physical activity levels according to the International Physical Activity Questionnaire (IPAQ-C) were included in the study.

Baseline assessment of cardiorespiratory fitness and physical activity levels was carried out for all participants before the commencement of the intervention program. Cardiorespiratory fitness was assessed using Cooper's 12-Minute Walk Test. The test was conducted on a flat, non-slippery surface under standardized conditions. Participants were instructed to walk as far as possible within a period of twelve minutes. The total distance covered was measured and recorded in meters. The obtained distance was then used to estimate VO_2 peak using the standard Cooper's predictive equation. Physical activity levels were assessed using the International Physical Activity Questionnaire (IPAQ-C), which evaluated the participants' engagement in walking, moderate-intensity activities, vigorous-intensity activities, and sedentary behavior.

After completion of baseline assessment, participants were allocated into two groups comprising twenty participants each. Group A received the Aerobic Exercise Program, while Group B received the Kuchipudi Dance Training Program. Both intervention programs were administered for a total duration of twelve weeks under supervision.Participants in Group A underwent a structured Aerobic Exercise Program consisting primarily of aerobic dance activities. Each session included a warm-up period, aerobic dance training, and a cool-down phase. The intensity and complexity of exercises were progressively increased throughout the intervention period in accordance with the participants' tolerance and fitness levels. The frequency of training was gradually progressed from three sessions per week during the initial weeks to five sessions per week during the final weeks of the intervention. Each session lasted approximately 40–60 minutes.

Participants in Group B underwent a structured Kuchipudi Dance Training Program under the supervision of a qualified Kuchipudi instructor. The program commenced with basic posture correction, body alignment training, and introductory adavus. As the intervention progressed, participants were introduced to intermediate adavus, jathis, dynamic footwork patterns, rhythmic movement sequences, abhinaya components, and performance-oriented choreography. The complexity, duration, and intensity of the dance sessions were progressively increased throughout the twelve-week training period. Similar to Group I, the training frequency progressed from three sessions per week to five sessions per week, with each session lasting approximately 40–60 minutes.To monitor the progression of participants, interim assessments were conducted at the end of the sixth week. Cardiorespiratory fitness was reassessed using Cooper's 12-Minute Walk Test, and physical activity levels were reassessed using the IPAQ-C questionnaire. These interim measurements helped in identifying changes occurring during the intervention period.

At the completion of the twelve-week intervention program, all participants underwent final assessment using the same outcome measures employed during baseline evaluation. Cardiorespiratory fitness was reassessed using Cooper's 12-Minute Walk / Run Test, and VO_2 peak values were calculated accordingly. Physical activity levels were reassessed using the IPAQ-C questionnaire. The pre-intervention, mid-intervention, and post-intervention values obtained from both groups were recorded systematically and entered into a database for analysis.

The collected data were tabulated and analysed using appropriate statistical methods. Descriptive statistics including mean and standard deviation were calculated for all outcome measures. Within-group comparisons were performed to determine the effectiveness of each intervention, while between-group comparisons were conducted to evaluate differences in outcomes between the Aerobic Exercise Group and the Kuchipudi Dance Group. Statistical significance was established at a p-value of less than 0.05. The results were presented in the form of tables, graphs, and figures, and were interpreted to determine the comparative effectiveness of aerobic exercise and Kuchipudi dance on cardiorespiratory fitness and physical activity levels among young females.

Interventions [23,24,25]:

12-week aerobic dance [24,25] and Kuchipudi dance [26,27] protocol:

- Frequency: 3-5 sessions per week
- Time: 45-60 minutes per sessions
- Type: Aerobic exercises (aerobic dance) for Group A and kuchipudi dance for Group B

Statistical analysis:

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics Version 20.0. Continuous variables were expressed as Mean ± Standard Deviation (SD). Baseline characteristics were analysed using descriptive statistics. A Mixed Repeated Measures Analysis of Variance (ANOVA) was used to evaluate the effects of Time (Pre-test, 6 weeks and 12 weeks), Group (Aerobic Exercise and Kuchipudi Dance) and Time × Group interaction for VO_2 Peak and IPAQ scores. Greenhouse-Geisser correction was applied wherever the assumption of sphericity was violated. Bonferroni post-hoc analysis was performed for pairwise comparisons. A p-value of <0.05 was considered statistically significant.Descriptive and inferential statistical analyses, including graphs were performed to address the study objectives, while required tables were prepared using Microsoft Excel.

Table 1: 12week intervention protocol for Group A and Group B

Week	Frequency	Duration per session	Group A: Aerobic Exercise	Group B: Kuchipudi Dance
1–2	3 sessions/week	40 minutes	Basic aerobic dance movements	Basic adavus and posture training
3–4	3 sessions/week	40 minutes	Rhythmic aerobic dance	Intermediate adavus and jathis
5–6	4 sessions/week	40 minutes	Progressive aerobic dance	Dynamic footwork and basic choreography
7–8	4 sessions/week	40 minutes	Continuous aerobic dance sequences	Nritta with repeated abhinaya
9–10	5 sessions/week	40 minutes	Cardio dance training	Performance-ready sequences
11–12	5 sessions/week	40 minutes	Progressive continuous aerobic dance	Continuous dance sequences

Results:

All statistical analyses were carried out using IBM SPSS Statistics Version 20.0. Descriptive and inferential statistical analyses, including graphs were performed to address the study objectives, while required tables were prepared using Microsoft Excel.

Variable	Group A (20 participants) Mean ± SD	Group B (20 participants) Mean ± SD
Age (years)	22.60 ± 1.10	22.65 ± 1.23
Height (cm)	163.20 ± 2.09	163.05 ± 2.63
Weight (kg)	62.40 ± 2.01	61.30 ± 3.92
BMI (kg/m²)	23.44 ± 0.56	23.05 ± 1.06
IPAQ Score – Pre-test	1587.50 ± 276.08	1710.00 ± 134.39
IPAQ Score – 6 Weeks	1936.65 ± 247.87	2264.00 ± 159.35
IPAQ Score – 12 Weeks	2490.00 ± 524.19	3031.45 ± 319.44
VO_2 Peak (ml/kg/min) – Pre-test	30.22 ± 0.96	30.55 ± 0.84
VO_2 Peak (ml/kg/min) – 6 Weeks	32.57 ± 0.98	33.73 ± 1.58
VO_2 Peak (ml/kg/min) – 12 Weeks	35.93 ± 2.21	39.40 ± 1.99

Table 2. Baseline Characteristics and Descriptive Statistics of Outcome Measures in the Aerobic Exercise (Group A) and Kuchipudi Dance (Group B) Groups

Table 2 presents the descriptive statistics of the study participants in the Aerobic Exercise (Group A) and Kuchipudi Dance (Group B) groups. The two groups were similar with respect to age, height, weight, and body mass index at baseline, indicating similar participant characteristics before the intervention. At baseline, the mean VO_2 Peak and IPAQ scores were also comparable between the groups. Over the 12-week intervention period, both groups demonstrated progressive improvements in cardiorespiratory fitness (VO_2 Peak) and physical activity levels (IPAQ scores). However, the Kuchipudi Dance group showed higher mean values than the Aerobic Exercise group at both the 6-week and 12-week assessments, suggesting greater improvements following the intervention. These descriptive findings are further evaluated using inferential statistical analyses in the subsequent sections.To address the primary objectives, a Mixed Repeated Measures ANOVA was conducted with Group (Group A: Aerobic Exercise and Group B: Kuchipudi Dance) as the between-subject factor and Time (Pre-test, 6 weeks, and 12 weeks) as the within-subject factor. This analysis was used to examine the effects of time, group, and their interaction on VO_2 Peak.

Group	**Pre-test (Mean ± SD)**	**6 Weeks (Mean ± SD)**	**12 Weeks (Mean ± SD)**
Group A (Aerobic Exercise)	30.22 ± 0.96	32.57 ± 0.98	35.93 ± 2.21
Group B (Kuchipudi Dance)	30.55 ± 0.84	33.73 ± 1.58	39.40 ± 1.99

Table 3: Descriptive Statistics of VO_2 Peak (ml/kg/min) in the Aerobic Exercise and Kuchipudi Groups

The Table 3 shows that there is progressive increase in VO_2 Peak in both the groups from baseline to 12 weeks. Although the baseline means of both the groups were similar, the Kuchipudi group showed a greater improvement in VO_2 Peak at both 6 weeks and 12 weeks compared with the Aerobic Exercise group.

Effect	**df**	**F-value**	**p-value**	**Partial η^2**
Time*	(1.660, 63.082)	485.81	<0.001	0.927
Group	(1, 38)	17.31	<0.001	0.313
Time × Group*	(1.660, 63.082)	23.95	<0.001	0.387

**Greenhouse-Geisser corrected values reported due to violation of the sphericity assumption (Mauchly's test: $W = 0.795$, $\chi^2 = 8.478$, $p = 0.014 < 0.05$).*

Table 4. Mixed Repeated Measures ANOVA for VO_2 Peak :According to Table 4, there was a highly significant main effect of Time ($p < 0.001$), indicating that VO_2 Peak improved significantly across the three assessment periods. Similarly, a significant main effect of Group ($p < 0.001$) indicated that the difference between the Aerobic Exercise and Kuchipudi groups is statistically significant. In addition, the significant Time × Group interaction ($p < 0.001$) demonstrated that the pattern of improvement over time varied between the two interventions, with the Kuchipudi group showing greater gains in VO_2 Peak.

Comparison	**Mean Difference**	**p-value**	**Interpretation**
Pre-test vs 6 Weeks	-2.77	<0.001	Significant improvement at 6 weeks
Pre-test vs 12 Weeks	-7.28	<0.001	Significant improvement at 12 weeks
6 Weeks vs 12 Weeks	-4.51	<0.001	Significant additional improvement between

			6 and 12 weeks

Table 5. Bonferroni Pairwise Comparisons for VO_2 Peak Across Time

Bonferroni-adjusted pairwise comparisons shown in Table-5 demonstrated significant improvements in VO_2 Peak between all assessment periods ($p < 0.001$). In particular, the negative values of Mean Difference (Pre –Post) indicate that participants showed progressive improvements from baseline to 6 weeks, baseline to 12 weeks, and from 6 weeks to 12 weeks.

Figure 3.1,3.2 : Estimated Marginal Means of VO_2 Peak Across the Three Assessment Time Points in the both Group A and Group B

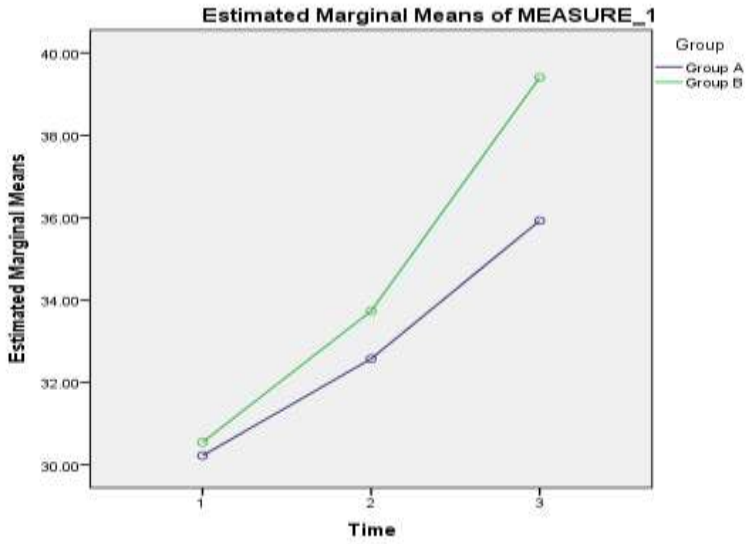


Fig. 3.1

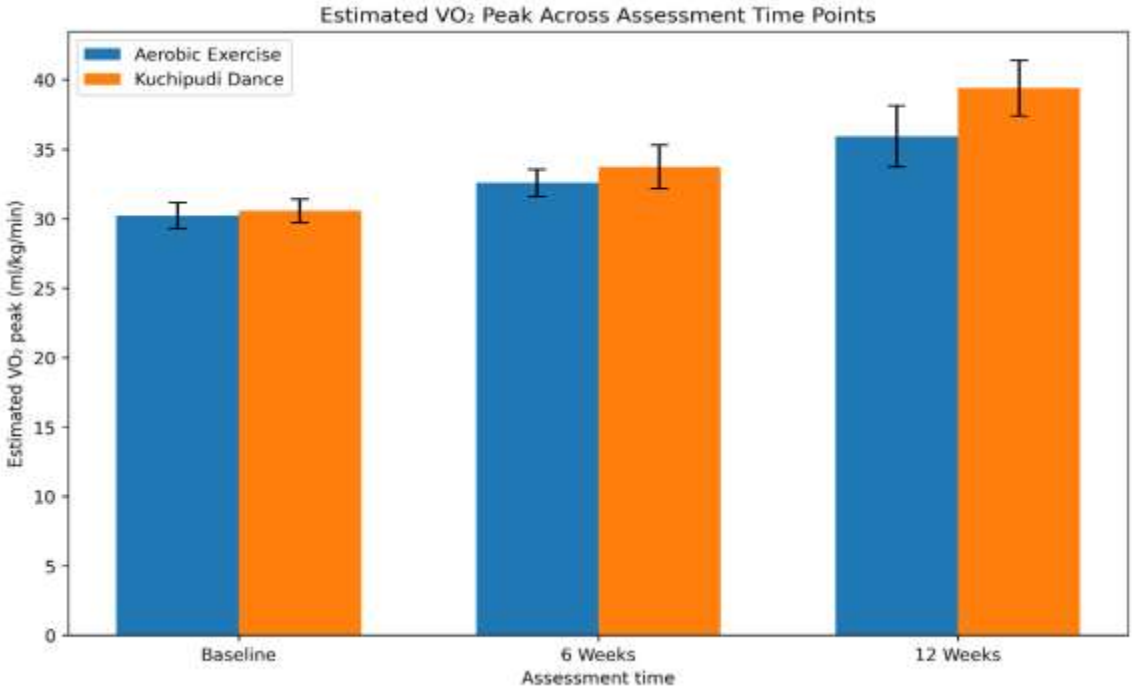


Fig. 3.2

Estimated Marginal Means of VO_2 Peak:

The above estimated marginal means plot clearly shows a progressive increase in VO_2 Peak from baseline to 6 weeks and 12 weeks in both the groups. Although both groups showed improvements over time, the Kuchipudi Dance group (Group B) revealed a steeper increase, particularly from Week 6 to Week 12, resulting in a higher VO_2 Peak at the end of the intervention. This pattern supports the significant Time × Group interaction, indicating that the improvement in cardiorespiratory fitness over time differed between the two intervention groups.

On the whole, the Mixed Repeated Measures ANOVA revealed a significant improvement in VO_2 Peak over the 12-week intervention period (Time effect, $p < 0.001$). There was also a significant overall difference between the Aerobic Exercise and Kuchipudi groups (Group effect, $p < 0.001$). Importantly, the significant Time × Group interaction ($p < 0.001$) indicates that the magnitude of improvement differed between the interventions. Based on the descriptive statistics, the Kuchipudi Dance group demonstrated greater improvements in cardiorespiratory fitness than the Aerobic Exercise group, particularly at the end of the 12-week training period. To address the secondary objectives, a Mixed Repeated Measures ANOVA was conducted with Group (Group A: Aerobic Exercise and Group B: Kuchipudi Dance) as the between-subject factor and Time (Pre-test, 6 weeks, and 12 weeks) as the within-subject factor. This analysis was used to examine the effects of time, group, and their interaction on IPAQ Peak.

Group	Pre-test (Mean ± SD)	6 Weeks (Mean ± SD)	12 Weeks (Mean ± SD)
Group A (Aerobic Exercise)	1587.50 ± 276.08	1936.65 ± 247.87	2490.00 ± 524.19
Group B (Kuchipudi Dance)	1710.00 ± 134.39	2264.00 ± 159.35	3031.45 ± 319.44

Table 6. Descriptive Statistics of IPAQ Scores in the Aerobic Exercise and Kuchipudi Dance Groups

According to Table 6, both groups demonstrated a progressive increase in IPAQ scores from baseline to 12 weeks. Although the Kuchipudi Dance group had slightly higher baseline physical activity levels, it exhibited greater improvements at both 6 weeks and 12 weeks compared to the Aerobic Exercise group.

Effect	df	F-value	p-value	Partial η^2
Time*	1.338, 50.847	393.50	<0.001	0.912
Group	1, 38	15.21	<0.001	0.286
Time × Group*	1.338, 50.847	13.80	<0.001	0.266

**Greenhouse-Geisser corrected values reported due to violation of the sphericity assumption (Mauchly's test: $W = 0.505$, $\chi^2 = 25.255$, $p < 0.001$).*

Table 7. Mixed Repeated Measures ANOVA for IPAQ Scores

The above ANOVA table shows that there was a highly significant main effect of Time ($p < 0.001$), indicating that physical activity levels improved significantly throughout the intervention period. There is also a significant main effect of Group ($p < 0.001$) indicated an overall difference in IPAQ scores between the Aerobic Exercise and Kuchipudi Dance groups.

In addition, the significant Time × Group interaction ($p < 0.001$) demonstrated that the pattern of improvement in physical activity levels differed between the two interventions, with the Kuchipudi Dance group showing greater improvements over time.

Comparison	Mean Difference	p-value	Interpretation
Pre-test vs 6 Weeks	-451.58	<0.001	Significant improvement at 6 weeks
Pre-test vs 12 Weeks	-1111.98	<0.001	Significant improvement at 12 weeks
6 Weeks vs 12 Weeks	-660.40	<0.001	Significant additional improvement between 6 and 12 weeks

Table 8. Bonferroni Pairwise Comparisons for IPAQ Scores Across Time

The above table of Bonferroni-adjusted pairwise comparisons showed significant increases in IPAQ scores between all assessment periods ($p < 0.001$). This indicates that participants demonstrated progressive improvements in physical activity levels from baseline to 6 weeks, baseline to 12 weeks, and from 6 weeks to 12 weeks.

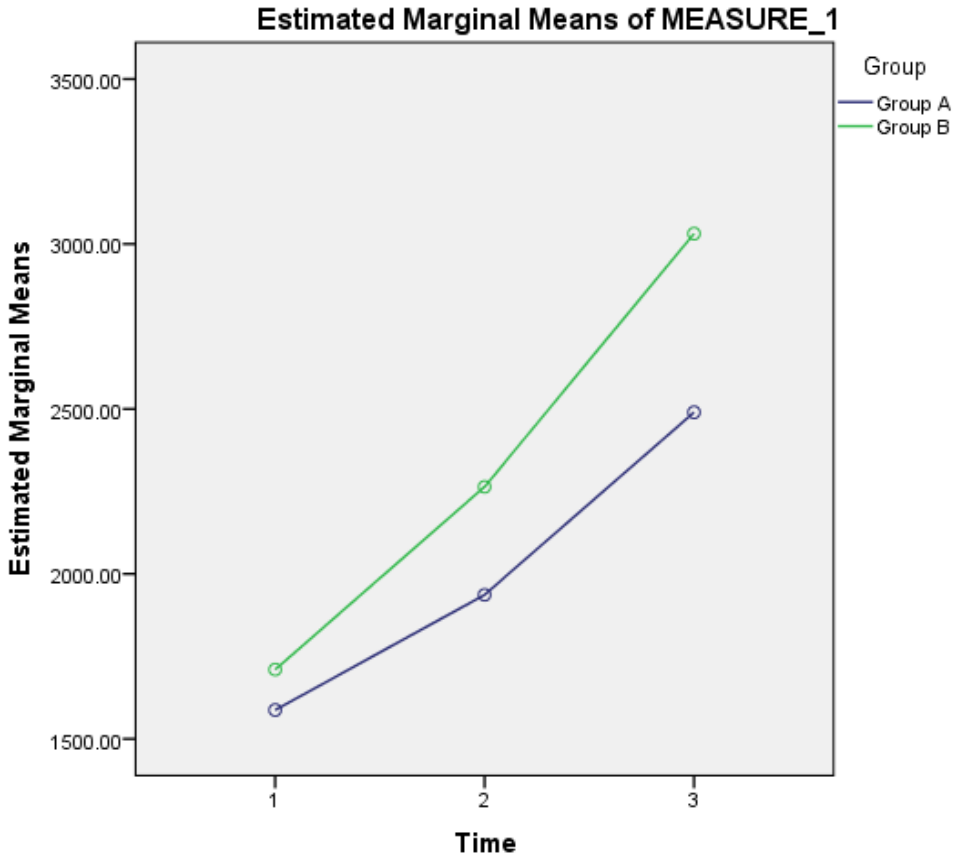


Fig. 4.1: Time Points in the Aerobic Exercise (Group A) and Kuchipudi Dance (Group B) Groups
Fig. 4.2

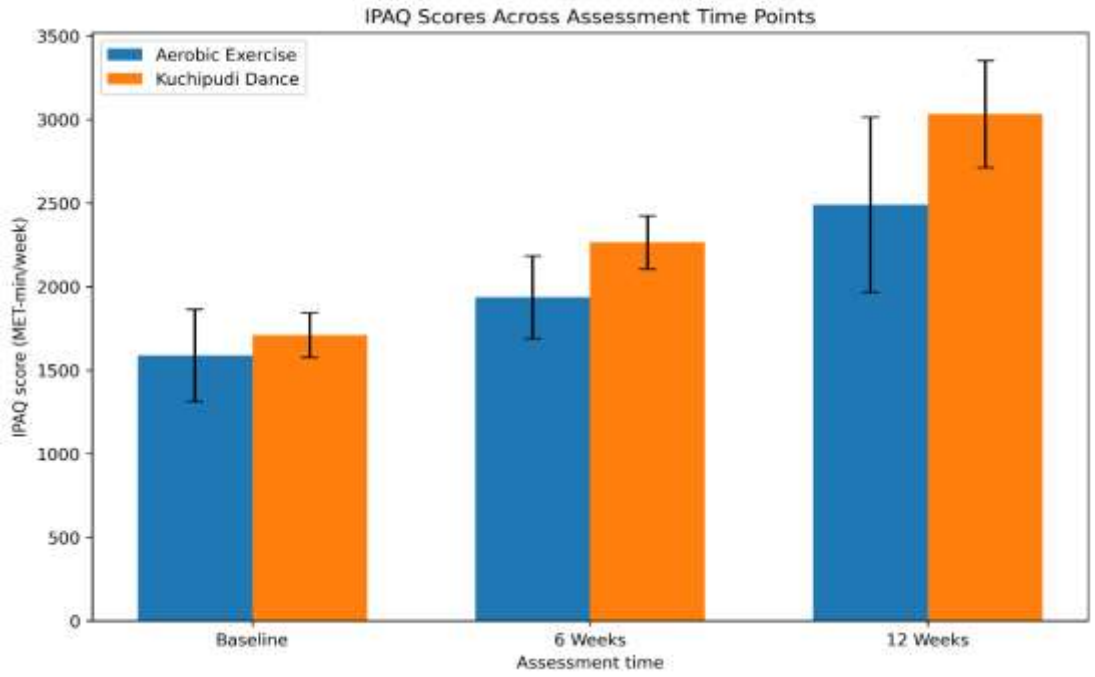


Figure 4.1,4.2 : Estimated Marginal Means of IPAQ Scores Across the Three Assessment Time Points in the Aerobic Exercise (Group A) and Kuchipudi Dance (Group B) Groups

The estimated marginal means plot (Figure 2) shows a progressive increase in IPAQ scores from baseline to 6 weeks and 12 weeks in both intervention groups. However, the Group B (Kuchipudi Dance group) demonstrated a steeper increase in physical activity levels than the Group A (Aerobic Exercise group), particularly at the end of the 12-week intervention.

This trend is consistent with the significant Time × Group interaction, indicating that the improvement in physical activity levels differed significantly between the two interventions.

On the whole, the Mixed Repeated Measures ANOVA demonstrated a significant improvement in IPAQ scores over the 12-week intervention period (Time effect, $p < 0.001$). There was also a significant overall difference between the Aerobic Exercise and Kuchipudi Dance groups (Group effect, $p < 0.001$).

Additionally, the significant Time × Group interaction ($p < 0.001$) indicates that the extent of improvement in physical activity levels differed between the interventions. Based on the descriptive statistics, the Kuchipudi Dance group (Group B) exhibited greater improvements in physical activity levels than the Aerobic Exercise group (Group A) following the 12-week intervention.

Discussion:

The present study was undertaken to compare the effects of a structured Aerobic Exercise programme and a Kuchipudi Dance training programme on cardiorespiratory fitness and physical activity levels among young females. Cardiorespiratory fitness is considered an important indicator of cardiovascular health and functional capacity, while adequate physical activity plays a vital role in preventing lifestyle-related disorders. Although aerobic exercise is widely recommended for improving cardiorespiratory fitness, traditional Indian dance forms such as Kuchipudi have recently gained attention as enjoyable and culturally acceptable modes of physical activity. Therefore, the present study attempted to compare the effectiveness of these two interventions over a period of 12 weeks.

Cardiorespiratory fitness, expressed as estimated VO_2 Peak, was the primary outcome measure of the present study. The findings demonstrated that both Aerobic Exercise and Kuchipudi Dance significantly improved cardiorespiratory fitness over the 12-week intervention period. However, participants who underwent Kuchipudi Dance training exhibited greater improvement in VO_2 Peak than those who participated in the Aerobic Exercise programme. The significant Time effect indicated progressive improvement throughout the intervention, while the significant Time × Group interaction demonstrated that the pattern of improvement differed between the two interventions, favouring the Kuchipudi Dance group. These findings suggest that although both interventions were effective, Kuchipudi Dance produced superior improvements in cardiorespiratory fitness.

The improvement observed following aerobic exercise may be attributed to well-established physiological adaptations associated with regular endurance training. Continuous aerobic exercise enhances stroke volume, cardiac output, pulmonary ventilation, peripheral oxygen extraction, skeletal muscle capillarization and mitochondrial oxidative capacity, thereby improving oxygen delivery and utilization during exercise. These adaptations collectively contribute to an increase in maximal oxygen uptake and exercise tolerance.[3,25,27,29]

Interestingly, the Kuchipudi Dance group demonstrated a greater increase in VO_2 Peak than the Aerobic Exercise group. A possible explanation is that Kuchipudi involves continuous rhythmic movements, dynamic footwork, repeated changes in posture, multidirectional stepping patterns, coordinated upper- and lower-limb activity, and sustained performance throughout the training session. Such movements require simultaneous activation of multiple muscle groups while maintaining rhythm, balance and postural control. Consequently, participants may have experienced greater overall energy expenditure and cardiovascular demand than during conventional aerobic exercise.

Another important factor contributing to the greater improvement may be participant engagement and exercise adherence. Kuchipudi combines physical activity with music, rhythm and artistic expression, making the sessions more enjoyable and motivating. Enjoyable exercise programmes are more likely to maintain participant interest, reduce perceived exertion and promote consistent participation. Better adherence to training may have contributed to the superior improvement observed in the Kuchipudi group.

The findings of the present study are consistent with the recommendations of the American College of Sports Medicine, which states that regular moderate-to-vigorous physical activity improves cardiorespiratory fitness through progressive cardiovascular and metabolic adaptations.[3] Similarly, Ross et al. emphasized that cardiorespiratory fitness should be considered a clinical vital sign because improvements in aerobic capacity are associated with reduced cardiovascular morbidity and mortality.[4] Myers et al. further recommended routine assessment of cardiorespiratory fitness as an essential component of preventive healthcare, highlighting that even modest improvements in aerobic fitness provide substantial health benefits.[5]

The physiological explanation proposed in the present study is also supported by Lavie et al., who reported that regular exercise improves myocardial efficiency, vascular function and aerobic performance, thereby reducing cardiovascular risk.[21] Kenney et al. and Powers and Howley described that repeated endurance activity increases cardiac output, mitochondrial density and oxidative enzyme activity, resulting in improved aerobic capacity.[25,27] Furthermore, Bassett and Howley explained that maximal oxygen uptake depends largely on oxygen transport and utilization, both of which are enhanced through regular endurance training.[29]

Overall, the findings indicate that both Aerobic Exercise and Kuchipudi Dance are effective interventions for improving cardiorespiratory fitness in healthy young females. Nevertheless, the greater improvement observed following Kuchipudi Dance suggests that culturally relevant, enjoyable and rhythm-based physical activities may serve as effective alternatives to conventional aerobic exercise for enhancing cardiorespiratory fitness.

Physical activity level, assessed using the International Physical Activity Questionnaire (IPAQ), was the secondary outcome measure of the present study. The findings demonstrated that both the Aerobic Exercise and Kuchipudi Dance groups showed progressive improvements in IPAQ scores from baseline to the end of the 12-week intervention. However, participants in the Kuchipudi Dance group exhibited greater improvement than those in the Aerobic Exercise group. The significant Time effect indicates that physical activity levels increased consistently throughout the intervention period, while the significant Time × Group interaction suggests that the magnitude of improvement differed between the two exercise programmes, with Kuchipudi Dance producing a greater increase in overall physical activity.

The increase in IPAQ scores observed in both groups may be attributed to regular participation in supervised exercise sessions, which encouraged participants to adopt a more active lifestyle. Repeated engagement in structured physical activity improves confidence, exercise tolerance, and motivation, leading to greater participation in daily physical activities. These behavioural changes are reflected in the progressive increase in IPAQ scores observed throughout the intervention period.

The comparatively greater improvement observed in the Kuchipudi Dance group may be explained by the enjoyable and culturally engaging nature of the intervention. Unlike conventional aerobic exercise, Kuchipudi combines rhythmic movement, music, coordination, balance, and artistic expression, which may reduce boredom and improve participant motivation. Increased enjoyment often leads to better adherence and sustained participation, thereby contributing to higher physical activity levels. Furthermore, the coordinated movement patterns and continuous lower-limb activity involved in Kuchipudi may have encouraged participants to remain physically active beyond the supervised training sessions.

The findings are also consistent with those of Esteban-Cornejo et al., who reported that females with higher levels of physical activity and cardiorespiratory fitness demonstrate better overall health and cognitive performance.[7] In addition, Mintjens et al. concluded that maintaining higher levels of cardiorespiratory fitness and physical activity during youth contributes to improved long-term cardiovascular health and reduced disease risk in adulthood.[8] Collectively, these studies reinforce the importance of encouraging regular physical activity among young females through enjoyable and sustainable exercise programmes.

The findings of the present study have important implications for physiotherapy practice and health promotion. Both Aerobic Exercise and Kuchipudi Dance were effective in improving cardiorespiratory fitness and physical activity levels among healthy young females. However, the greater improvements observed in the Kuchipudi Dance group suggest that traditional Indian dance can be considered an effective and culturally acceptable exercise modality for promoting cardiovascular health.

Physiotherapists may incorporate dance-based exercise programmes into preventive health initiatives, community wellness programmes, college health promotion activities, and women's fitness programmes. Such interventions may improve exercise adherence by providing an enjoyable alternative to conventional aerobic exercise while simultaneously enhancing physical fitness. The use of culturally familiar activities may also encourage long-term participation, thereby contributing to sustained improvements in cardiorespiratory fitness and overall health.

Conclusion:

The present study demonstrated that both a structured Aerobic Exercise programme and a structured Kuchipudi Dance training programme were effective in improving cardiorespiratory fitness and physical activity levels among healthy young females over a 12-week intervention period.

Estimated VO_2 peak showed a progressive and statistically significant improvement from baseline to 6 weeks and from 6 weeks to 12 weeks in both intervention groups. However, the significant Time × Group interaction demonstrated that the magnitude of improvement differed between the two interventions, with the Kuchipudi Dance group demonstrating greater improvement in estimated VO_2 peak than the Aerobic Exercise group.

Similarly, physical activity levels assessed using the IPAQ demonstrated significant progressive improvement across the intervention period in both groups. The significant Time × Group interaction indicated a significantly greater improvement in IPAQ scores in the Kuchipudi Dance group compared with the Aerobic Exercise group.

Therefore, within the population and conditions studied, both Aerobic Exercise and Kuchipudi Dance were effective in improving cardiorespiratory fitness and physical activity levels; however, the structured Kuchipudi Dance programme demonstrated significantly greater improvements in both outcomes over the 12-week intervention period.

These findings suggest that Kuchipudi Dance may be considered a potential culturally relevant, enjoyable and structured exercise modality for promoting cardiorespiratory fitness and physical activity among healthy young females. Further research involving larger samples, rigorous randomization, objective physical-activity monitoring and direct measurement of cardiopulmonary exercise capacity is warranted to confirm these findings and establish their broader applicability.

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