

Effectiveness of Aerobic Training on Lung Volume, Exercise Capacity and Gait Speed in Individuals with Chronic Kidney Disease

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Abstract

Background: Kidney disease (CKD) is a disorder in which the kidneys have been damaged and are unable to filter blood as effectively as they should. As a result, extra fluid and waste from the circulation linger in the body, potentially leading to various health issues like heart disease and stroke. This also causes swelling in the lower limb causing reduced mobility and altered lung volume. This reduction in mobility can be improved with exercise. Aerobic training has been proved to be one of the most effective treatments for improving lung volume capacity. Aerobic training using cycling exercise can improve both lung volume capacity and mobility together.

Purpose: To analyze the Effect of Aerobic training and lung volume and gait speed capacity in individuals with chronic kidney disease.

Materials and Methods: Sixty individuals with chronic kidney disease were selected according to inclusion and exclusion criteria in which 48 individuals completed the study and 12 quit. These individuals were treated with bed side cycling and spirometry for 8 weeks, 1 session per day. Their Pretreatment Gait speed test scoring, 3-minute walk test, were recorded. After the treatment duration the same test was repeated.

Results: There is an Improvement in Gait speed and 3-minute walk test after giving incentive spirometry stage of CKD Individuals. No adverse events were observed during and after the treatment.

Conclusion: Individuals with CKD need aerobic training to improve their lung volume capacity. The current study concludes that there is an improvement in Gait speed and 3-minute walk test after the treatment session of incentive spirometry and Bedside cycle ergometer.

Clinical Significance: This study's clinical significance lies in assessing how aerobic training impacts lung volume capacity in chronic kidney disease patients. Improved lung function may lead to better cardiovascular health, enhanced quality of life, and reduced complications. These findings could support tailored exercise programs to improve the well-being and overall health of individuals with chronic kidney disease.

Key Words: Gait speed test scoring, 3-minute walk test, CKD, Aerobic training, Bed side cycling, Incentive Spirometry.

Introduction

Chronic kidney disease (CKD) is a global health concern, and its classification and assessment have

evolved over the years. Various terms, such as "chronic renal failure," "chronic renal insufficiency," "pre-dialysis," and "pre-end-stage renal disease,"

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have been used to describe different stages of CKD based on underlying causes. However, there is a growing need for standardized terminology and a comprehensive approach to understanding and managing CKD. The National Kidney Foundation (NKF) established clinical practice guidelines in 2002, which have been crucial in the analysis, classification, and evaluation of CKD. Nowadays, CKD encompasses the entire spectrum from early stages to end-stage renal disease (ESRD), highlighting the importance of early detection, risk assessment, and appropriate interventions to slow disease progression and prevent complications. To address the rising health burden of CKD, guidelines and frameworks have been developed to assist healthcare professionals in evaluating, classifying, and stratifying CKD. By implementing evidence-based interventions, these resources aim to improve individual outcomes and reduce the global impact of CKD [1]. CKD has complex interactions with various bodily systems, leading to significant physiological changes affecting individuals' health and well-being. Gastrointestinal problems, skin changes, and persistent itching are among the issues associated with CKD. Furthermore, CKD Individuals are at an increased risk of developing cardiovascular disease, emphasizing the importance of exercise training as a preventive measure. Muscle loss, decreased strength, impaired physical function, and reduced cardiorespiratory fitness are common in CKD, increasing cardiovascular risk and potential complications. Individuals undergoing haemodialysis is often face limitations in their daily activities, leading to physical deconditioning and reduced exercise tolerance [2][3][4]. Exercise interventions have been studied extensively for CKD Individuals and have shown positive impacts on health and quality of life. Engaging in aerobic exercise can improve aerobic capacity, aerobic fitness, muscle strength, and mass. Exercise can be assessed using maximal graded tests like the incremental shuttle walking test or submaximal tests like the 3-minute walk test [14]. However, despite the benefits of exercise, its widespread incorporation into standard practice has been hindered by limited duration, small sample sizes, and methodological limitations of previous studies [8]. Bedside cycling is a practical and accessible form of exercise for individuals with restricted mobility or those unable to engage in conventional

exercises. It provides cardiovascular and respiratory benefits and is adaptable to various medical settings. As healthcare professionals recognize its importance, bedside cycling is becoming a critical component of physical therapy and rehabilitation programs, enabling individuals to actively participate in their recovery process [6]. Incentive spirometry (IS) is a useful technique for practicing deep breathing exercises and enhancing lung health. It allows individuals to independently perform deep breathing exercises while receiving visual feedback on their inspiratory effort. After surgery, using an incentive spirometer can help maintain lung health and prevent congestion. Inspiratory muscle training involves stretching and exercising the lungs, promoting active lung involvement during the recovery phase after surgery [7]. A peak flow meter is a compact and portable device used to assess an individual's peak expiratory flow rate (PEFR). It is frequently employed in monitoring and controlling respiratory disorders like asthma. PEFR measures the highest velocity at which a person can forcefully exhale air after a deep inhalation. Monitoring changes in PEFR can help assess the effectiveness of cardio physiotherapy interventions, including exercise programs and breathing exercises, allowing the cardio physiotherapist to tailor the treatment plan and track progress [17]. CKD is a significant global health issue, and its understanding and management have evolved over time. Standardized terminology and comprehensive approaches have become essential to address this growing health burden effectively. Exercise interventions have shown promise in improving the health and quality of life of CKD Individuals. Bedside cycling, incentive spirometry, and peak flow meters are valuable tools in promoting cardiovascular and respiratory health and aiding in the rehabilitation process. By recognizing the importance of these interventions and conducting further research, healthcare professionals can enhance the care and well-being of CKD Individuals worldwide.

AIM

To analyze the Effects of Aerobic training on lung volume, exercise capacity and gait speed in Individuals with CKD.

Materials and Methods

60 individuals with chronic kidney disease were selected according to inclusion and exclusion criteria. These individuals were treated with bed side cycling and spirometry for 2 weeks, 1 session per day. Their Pretreatment Gait speed test scoring, 3-minute walk test, were recorded. After the treatment duration the same test was repeated.

Study Period: June2023 - July2023

Inclusion criteria:

- Both male and female
- Age group- 20-60 years
- Individuals with CKD without Back pain
- Individuals with Chronic Kidney Conditions GFR values of 15-90 mL.

Exclusion criteria:

- Individuals with cardiopulmonary infections
- Individuals with Back pain
- uncontrolled low or high blood pressure
- Physical impairment sufficient to prevent undertaking the intervention.
- Recent myocardial infarction
- Upper limb and lower limb amputated Individuals
- Unstable chronic conditions
- Daily dialysis Individual

Outcome Measure

To determine the effectiveness of aerobic exercise on Peak expiratory flow rate using peak flow meter, the effectiveness of cardiovascular endurance by 3-minute walk test, the effectiveness on gait speed using gait speed test.

Procedure

The study was conducted at Saveetha College and Hospital, involving 60 individuals with CKD who were under dialysis (CKD stage 1-5). The participants were selected based on specific inclusion and exclusion criteria. Each individual was thoroughly explained about the procedure, and informed consent was obtained from all of them. In which 12 didn't complete the study and 48 individuals completed the study successfully. Prior to the treatment, all

necessary arrangements were made. First the pre-tests were taken before the treatment. The following are the procedure for pre and post test

3-Minute Walk Test:

The subject's vitals were taken before the test. A cone with a beginning and ending point was used to indicate a 10-meter stretch of ground. The person was given instructions to walk the 10 meters for three minutes while having their vital signs monitored.

Gait Speed Test

A distance of 8 metres, split into 2+4+2 metres, was indicated on the floor. The person was instructed to walk the distance, and the moment their leg touched the line at the third metre was timed. When their final leg reached the sixth metre, the test was declared over. The results of this exam were recorded after it was conducted twice.

Peak Expiratory Flow Rate:

The person received a peak expiratory flow rate device. They were instructed to adopt a comfortable posture when standing or sitting, securely grip the mouthpiece to prevent air from escaping, and forcefully exhale. The best result was recorded when this method was done three to four times. Pre-vitals were noted during the course of the therapy.

After the pretest the Treatment is preceded by

Treatment Protocol

Treatment Duration: 45 minutes.

Incentive spirometry: Inspiration 20 reps ,1 set per day and Expiration 20 reps 1 set per day. (10 minutes)

Cycle Ergometry:

Warm up period B/L AROM 10 reps 1 set per day (5 minutes)

Stretches: Upper and Lower limb stretches (5 minutes)

Cycling: 3 minutes cycling in Clockwise direction, 2 minutes rest, 3 minutes cycling in Clockwise direction (10 minutes)

Cool Down: 2 minute rest , Upper and Lower limb Stretches (5 minutes).

Incentive Spirometry:

The process was first explained to the patient. The patient is asked to hold the device in an upright position and they are told to close the mouthpiece with their mouth and do a forceful inspiration via mouth and expiration via nose and then hold the device in upside down position and do forceful expiration via mouth and inspiration through nose.

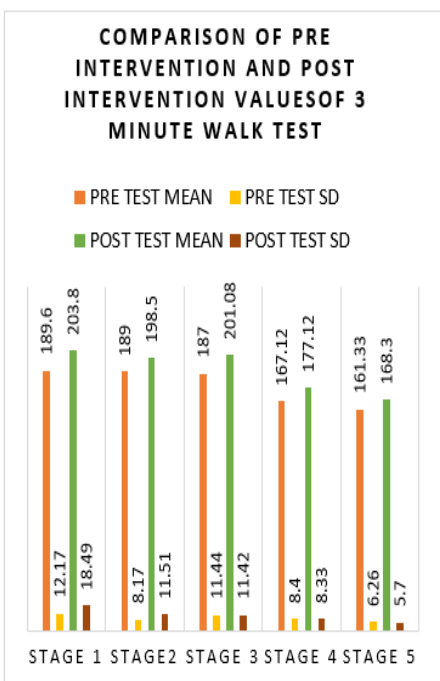
Bed Side Cycling:

There were instructions for a warm-up that included bilateral upper- and lower-limb arm exercises. Then, either while sitting up or lying down, bedside cycling was carried out. The patient’s comfort was taken into consideration when setting up the cycle ergometer. After cycling for 3 minutes in a clockwise manner, the patient had a 2-minute break before cycling for 3 minutes in the opposite way. After a three-minute period of rest, post-vitals were taken to make sure the patient was in good health.

After every session the post vitals are checked, in the same way the treatment was repeated for alternate days for 8 weeks resulting in a total of 28 sessions.

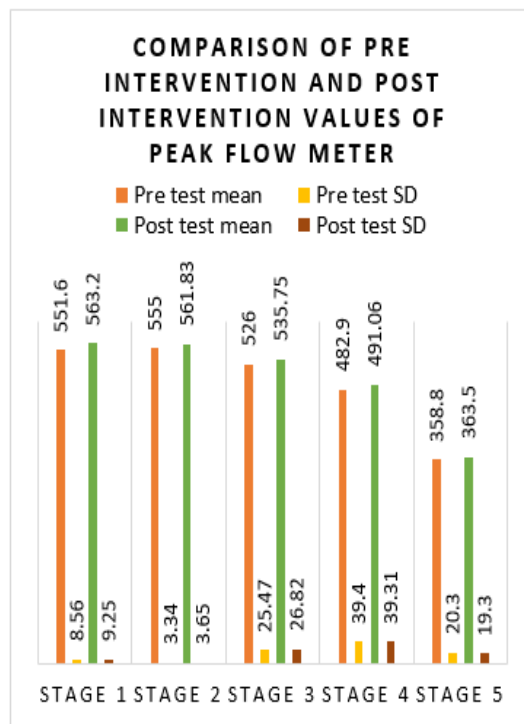
And the post tests of all sessions were tabulated and carefully recorded and analysed.

Data Analysis



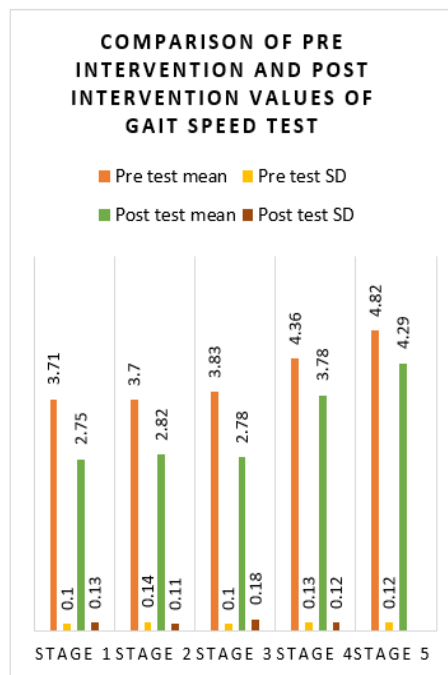
Graph 1:

INTERPRETATION: Graph 1 shows that the values are statistically significant



Graph 2:

INTERPRETATION: Graph 2 shows that the values are statistically significant



Graph 3:

INTERPRETATION: Graph 3 shows that the values are statistically not significant

Results

A total of 48 Individuals were included in the study out of them stage I stage II stage III stage IV stage V. Mean age of the Individual with standard deviation was 34.2, 2.6 years respectively. The pre intervention and post intervention Mean and standard deviation were mentioned in following tables 1,2,3. Stage I, II, III, IV, shows statistically improvement with the p value <0.05 whereas stage V was not significant. Twelve individuals were excluded from the study due to various reasons: three of them had deceased, four individuals experienced an increase in blood pressure and four with low back ache and cramps, and the remaining one individual were shifted to daily dialysis due to changes in their glomerular filtration rate (GFR). Aerobic exercise is necessary for Individuals with Chronic Kidney Disease (CKD) to improve their lung volume capacity. The results of this study show that bedside cycle ergometer use and incentive spirometry led to substantial gains in gait speed and the 3-minute walk test. The study's goal was to examine the possible advantages of aerobic exercise in enhancing respiratory function in people with CKD. The use of incentive spirometry and bedside cycle ergometer sessions were two particular therapies. Through slow, deliberate inhalations into a mouthpiece, Individuals are urged to attain a target volume depending on their capacity during incentive spirometry. Following a maximum inhalation, individuals were advised to hold their breath for a brief interval before repeating the cycle ten times. The goal was to exhale quietly and slowly, without closing the mouth around the mouthpiece. The need of proper breathing techniques was highlighted, notably the importance of extending the lower rib cage during maximal intake rather than depending only on accessory muscles. Individuals were positioned in a supine reclining posture with the head end of the bed elevated to 30° for the second intervention, the bedside cycle ergometer. The lower limbs underwent an active range of motion activities throughout the 10-minute warm-up period. Individuals' feet were firmly fastened to the pedals of the cycle ergometer, which was placed at the foot of the bed. They were told to bike for 6 minutes in a clockwise manner, stop for 3 MINUTES, and then cycle for another 6 minutes in an anticlockwise direction. This treatment plan was followed for 8 weeks on alternate days with no

resistance being imposed. The researchers assessed the individuals' improvements in the 3-minute walk test and gait speed after the intervention period. Results showed a considerable improvement in both metrics, demonstrating the effectiveness of aerobic exercise in enhancing Individuals' functional mobility and walking ability. This study adds to the expanding body of research that shows how crucial aerobic exercise is for those with CKD. The bedside cycle ergometer sessions and incentive spirometry therapies have shown potential in improving gait speed and the 3-minute walk test. These gains represent the potential advantages of such therapies in enhancing the pulmonary function and general wellbeing of CKD Individuals. However, the full research report must be read in order to fully comprehend the study's findings and implications since it may offer more information on the methodology, data analysis, and other study limitations. Additional investigation in this field may help create aerobic training programmes for CKD Individuals that are more focused and effective, thereby enhancing their quality of life and functional capabilities.

Discussion

Chronic kidney disease (CKD) is a condition characterized by kidney damage that reduces blood filtration efficiency, leading to fluid and waste accumulation in the body. This can result in various health issues, including heart disease and mobility problems. To address these challenges, a stationary bedside cycle ergometer has been utilized to facilitate arm and leg cycling movements for CKD Individuals, improving their physical strength and functional recovery. Additionally, exercise has shown potential anti-inflammatory effects and benefits in lipid profile and dialysis adequacy in CKD patients. Recent studies emphasize the importance of early detection and appropriate interventions to slow disease progression and enhance individual outcomes. A pilot study with CKD children and adolescents demonstrated promising anti-inflammatory effects of exercise, while a randomized controlled trial combining functional training and intradialytic cycling resulted in improved lipid profiles and dialysis adequacy^[12]. However, further research is needed to validate these findings and explore the potential benefits of exercise

in CKD care. A study conducted at SAVEETHA HOSPITAL in Chennai with 60 CKD Individuals from stages 1 to 5 showed significant improvements in stages I, II, III, and IV, while stage V did not exhibit significant improvement after the treatment.

Conclusion

Chronic kidney disease (CKD) is characterized by kidney damage leading to impaired blood filtration, causing fluid and waste buildup and various health problems. To address this, a stationary bedside cycle ergometer aids CKD Individuals by improving physical strength and functional recovery. Exercise has shown potential anti-inflammatory effects and benefits in lipid profile and dialysis adequacy. Early detection and appropriate interventions are crucial for better outcomes. Studies on CKD children and adults demonstrated promising results, while a randomized controlled trial combining functional training and intradialytic cycling showed positive effects. A study at SAVEETHA HOSPITAL with 60 CKD Individuals showed significant improvements in stages I-IV, except for stage V.

Ethical Clearance: Taken from institutional ethical committee

Funding: Self

Conflict of Interest: Nil

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