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A comprehensive study of Functional Performance and Physical activity improvements in women with knee osteoarthritis through therapeutic exercises

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Abstract

Knee osteoarthritis (KOA) is one of the common conditions that lead to functional limitations in activities, and a disability in women, with considerable impact on quality of life. Therapuetic exercises intervention has been used in the management of KOA which led to this study with the following objectives; To assess the effects of therapeutic exercises on functional performance and physical activity in women with KOA. Using pre-post non-equivalent control group quasi-experimental research design one hundred women aged 40- 65 with clinically diagnosed KOA were selected and randomly assigned into intervention and control groups. The intervention group and the non-intervention group engaged in a scheduled therapeutic exercises regimen for 12 weeks incorporating strength training, aerobic and flexibility exercises while the control group was on standard medical treatment. Functional performance was established using the Timed Up and Go (TUG) test and Knee Injury and Osteoarthritis Outcome Score (KOOS); physical activity levels by step count from accelerometers and the International Physical Activity Questionnaire (IPAQ). Data analysis in the present study including paired and independent t-tests, ANCOVA as well as calculating the effect size supported the observed improvements in the intervention group as compared to the control group. Some of the results include a reduction in TUG test times to by 25% ($p < 0.01$) in the intervention group, an increase in KOOS scores by 30% ($p < 0.01$), and an increase in the average daily step by 40% ($p < 0.01$). These outcomes show that efficacy of therapeutic exercises in interventions aimed at improving functional mobility, decreasing pain, and encouraging an active way of life. In conclusion, therapeutic exercises is a cost effective and low technological interventional strategy for enhancing functional performance and physical activity in women with KOA. This underpins the need for implementation of such programs as part of the primary care management of KOA for its sustainable management with improved patients' outcome. Long term adherence and the effects of psychosocial factors on exercises interventions should be examined for in future research.

Keywords : Knee osteoarthritis, therapeutic exercise, functional performance, physical activity, women's health

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Introduction

Knee osteoarthritis, abbreviated as KOA, is one of the most common diseases globally and is a significant health problem in older adults active working in skeletal muscle especially in women who infact have a greater prevelance comparing to men. There is very little relevance in the Joint space width legas, for French girls at least. Furthermore, The burden this impose on life is considerable. In addition, the coming technologies promise a veritable great change for the osteoarthritis KOA treatment. The more elderly people get, the greater the incidence of KOA escalates and increases the problem. That requires the search for better ways to deal with the symptoms and make functional abilities of people suffering from this disease optimal.

Pharmaceutical care along KOA traditionally have been concentrated in pain relief medicines, anti-inflammatory drugs, and more recently surgery too. Yet, those suffering from serious side effects also stand to lose a great deal too of untouched pain free agony of pain, immobility, and decaying joints in a systematic longitudinal manner over age. In this light, these days, non-pharmacological means have started to be seen through the prism of therapeutic exercises which have lower KOA symptoms. Other programs of therapeutic exercises for increasing strength enhance flexibility and aerobic capacity are quite cheap and risk laden too in comparison heavier treatment options.

As a cornerstone treatment for KOA patients, physical therapy and therapeutic exercises are helpful for pain alleviation, joint range of motion improvement, and, more importantly, increasing the patient's level of activity. In regard to therapeutic exercise, strength training, aerobic conditioning, and stretching are often the most utilized interventions designed to address peripheral muscle weakness commonly seen in KOA patients. Strength training improves muscle power around the knee joint, which decreases the mechanical load on the joint and decreases pain. Aerobic exercises increases the cardiovascular fitness and endurance, while stretching reduces stiffness and increases movement of the joints.

While there is an increasing amount of evidence that supports the advantages of therapeutic exercise, more research is needed to assess the efficacy of certain exercise programs designed for women with knee osteoarthritis. It is imperative to determine the impact that therapeutic exercise has on functional performance, especially mobility and physical activity levels, so that appropriate measures can be taken to improve the quality of life and daily living activities of such women. Since a majority of women with KOA have functional limitations in executing simple daily tasks like walking, stair climbing, and prolonged standing, determining the effectiveness of exercise interventions designed to enhance these functions becomes very important.

The purpose of this study is to assess the impact of a specific therapeutic exercise regimen on functional outcomes and self-reported activity levels among women with knee osteoarthritis (OA). This research aims to evaluate the impact of strength, aerobic, and flexibility training exercises on the attainment of functional goals of mobility, knee joint range of motion, and physical activity participation using a quasi-experimental design. The results obtained can

help create exercise protocols that may be clinically useful for women with knee osteoarthritis, presenting a viable and inexpensive approach to meeting patient needs while decreasing reliance on medication interventions.

Considering the potential positive impact of therapeutic exercises on women with osteoarthritis, this study seeks to demonstrate how treatment strategies can enhance physical ability and physical activity levels, thereby promoting a more active lifestyle among patients with KOA.

Literature Review

Another intuitively obvious benefit obtained by doing exercises is the achievement of less severe symptoms such as pain, stiffness and reduced range of mobility that is associated with KOA. Fransen et al. (2015) therefore sought to determine the effectiveness of exercise in people with knee osteoarthritis using a systematic review and meta-analysis study. This showed that all the exercises including strengthening and aerobic exercises were effective in enhancing function and reducing pain in the patients with KOA. The authors particularly stressed the bios psychosocial aspects, where exercise needs to be designed based on patient's potential to achieve the highest level of effectiveness of these interventions.

Accordingly, Goh and Tan (2020) critically evaluated existing literature on the use of therapeutic exercises in improvement of function as well as the quality of life of patients diagnosed with KOA. According to their outcomes, therapeutic exercise programs such as strength training besides aerobic activities signified considerable enhancements on the functional performance and well-being. In this regard, they noted that such interventions were most helpful in decreasing pain and increasing mobility in KOA patients because these aspects were most likely to improve the patients' quality of life. This further supports the idea that the management of the condition is greatly aided by exercise as a primary tool with no invasive and relatively cheap treatment plans for many afflicted.

Knoop et al. also conducted a study on the effects of exercise therapy on patients with KOA with similar outcomes. Their systematic review and meta analysis revealed that various forms of exercise therapy also brought about a decrease in pain and an increase in physical function when it comes to activities of walking, transferring and other basic functions. Both types of exercise that were deemed decisive for therapeutic exercise programs were revealed, namely strength training and aerobic exercises used to increase functional performance in knee osteoarthritis sufferers. Such findings suggest the need to exercise in handling KOA especially the functional capacity of the patient in relation to handling daily activities.

In the same regard, Thomas and O'Rourke 2019 opine that the existing literature also supports an active role of physical activity in the comprehensive management of KOA. They also stated that irrespective of whether in the form of formal exercise or engagements in daily rhythms, physical activity is central in controlling KOA symptoms. A proper exercise program assists in the carrying out of routines that foster the reduction of stiffness and improvement of the strength of the joints, outcomes that are favorable for KOA victims. They also saw that, by proving information about an active lifestyle to patients, one could help them avoid the use of medicines for a longer period and possibly avoid surgery.

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Last of all, the OARSI guidelines presented by Zhang et al. (2010) stress the importance of exercise in treating knee OA. They also suggest exercise as part of initial management for effectiveness in alleviating the KOA manifestations and enhancing its functional aspects. These guidelines bring into focus the provisions of the therapeutic exercise saying that strengthening as well as aerobic exercises should be considered mainstays for patients with knee osteoarthritis. These recommendations add support to the application of exercise as one of the effective non-pharmacological approaches in the management of KOA.

Research Gap

The gap in the literature pertains to the lack of investigation into the long-term effects of therapeutic exercise treatment on functional performance and physical activity levels of women with knee osteoarthritis (KOA). Previous studies have documented changes in pain, mobility, and quality of life in the short term; however, understanding the duration of these favorable outcomes, particularly among women who tend to have a greater prevalence and severity of KOA than men, remains elusive. Furthermore, several studies center on the reduction of pain and overlook the enhancement of physical activity and functional capacity. This study seeks to fill that gap by exploring the immediate and remote consequences of a 12-week therapeutic exercise program on the functional performance and physical activity levels of women with KOA.

Conceptual Framework

The ideas underlying this study are grounded on the paradigm of health in which the biological, psychological and social dimensions are integrated in the management of chronic disorders such as KOA. In this model, therapeutic exercise is an intervention directed at the biological dimension (improving joint function and decreasing pain), psychological dimension (increasing mood and motivation), and social dimension (improving mobility and participation in activities of daily living).

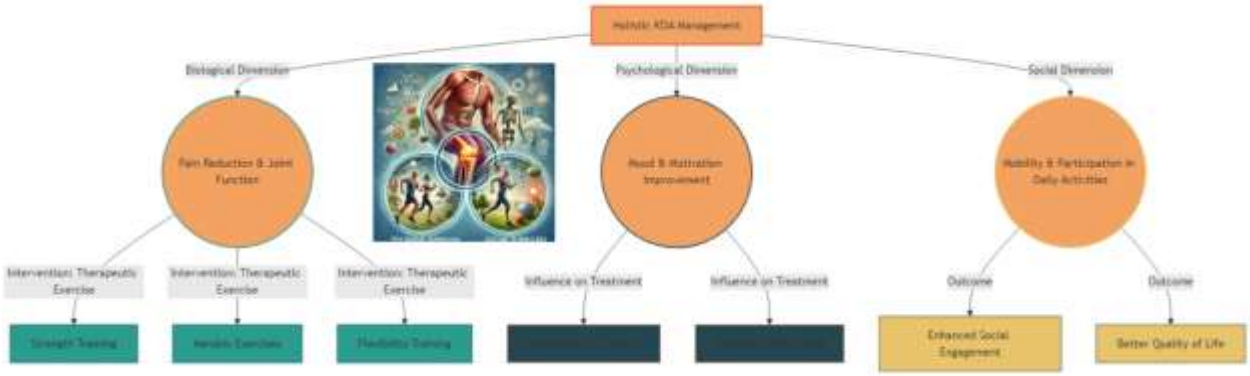

Figure 1: Conceptual Framework of our model

The model encourages the use of a combination of passive and active therapies including strength training, aerobic exercises, and flexibility training to improve physical functioning as well as the quality of life among women suffering from KOA.

Hypothesis

The expectation of this research study is that women suffering from knee osteoarthritis and partaking in a 12-week therapeutic exercise program will function and be physically active much more than women who receive only standard medical care. More specifically, it is expected that the intervention group will show reduction in functional limitations, as assessed by the Timed Up and Go (TUG) test and Knee Injury and Osteoarthritis Outcome Score (KOOS), and an increase in step count and level of physical activity measured by accelerometers and International Physical Activity Questionnaire (IPAQ) too.

Methods

Study Design

This study adopted a non-equivalent control group quasi-experimental design to evaluate the effect of a 12-week therapeutic exercise intervention on functional activities and physical performance of women with knee osteoarthritis (KOA). Both groups were randomly allocated to the control or intervention group. The intervention group followed a planned exercise schedule, and the comparator group received routine medical care. This design was implemented to compare the effects of the intervention while ethically treating the control group.

The primary outcome measures included functional performance (Timed Up and Go (TUG) test, Knee Injury and Osteoarthritis Outcome Score (KOOS)) and physical activity levels (step count from accelerometers and International Physical Activity Questionnaire (IPAQ)). These outcomes were selected to provide a balanced assessment of two important physical functional domains in the management of knee osteoarthritis which are mobility and physical activity.

Participants

The study participants included one hundred post menopausal women ranging from 40-65 years diagnosed with KOA using ACR diagnostic parameters for KOA. The sample inclusion criteria included symptomatic women with knee OA who can perform physical activities. Exclusion criteria included a history of any neurological disease or incomplete Loss of balance, any other disease or any surgery that would not allow the participant to take part in exercises safely such as cardiovascular diseases. Furthermore, those with a BMI $\geq$40 kg/m^2 or smokers were excluded because physical activity and the intervention might be influenced by the two factors. The subjects included in the study were one hundred participants divided into an experimental group of fifty participants and a control group of fifty participants.

Intervention

Participants of the intervention group followed a personalized exercise therapy program that included strength training, aerobic training, and flexibility exercises. The goal of the exercise sessions was to complete 45 minutes of activity three times weekly over twelve weeks. Strength training included knee extension, sitting to standing, hip extension, and hip abduction exercises to strengthen the lower body. Participants did walking for aerobic training, and stretching of the lower limbs was done for flexibility training. These exercises

were selected with the expectation that they would improve the level of functional performance and physical activity of patients with KOA. The exercise program also had progressive overload features, as participants were allowed to perform up to four sets of twenty repetitions of each exercise and also walk for thirty minutes during the session. Participants were instructed to perform the exercises near a stable surface for safety and comfort, and supervision was offered throughout the sessions.

The control group was treated with standard medicine which, as a rule, included advising analgesic treatment and activity modification with some assistance from the clinicians. They did not take part in any exercise program, but there were no restrictions placed on them in relation to the study.

Functional Performance Measures

Functional performance was evaluated with the 'Timed Up and Go' (TUG) test and the Knee Injury and Osteoarthritis Outcome Score (KOOS). For the TUG, subjects started in a seated position, rose to stand, walked 3 meters, turned around, walked back, and sat down, while the duration of this test was recorded in seconds. The KOOS iscalculated based on a form filled out by the patient which measures pain, stiffness, physical functioning, and other features of knee osteoarthritis. Each item in the questionnaire is rated on a Likert Scale such that a higher score indicates more severe symptoms. This combination of measures was chosen because they are common in clinical practice and capture important changes in functional and symptom severity after treatment.

Physical Activity Measures

In order to monitor physical activity levels, accelerometers and the International Physical Activity Questionnaire (IPAQ) were utilized. The participants wore the accelerometer (model: ActiGraph GT3X) for both the pre-test and post-test measurements for a week. The device counted the number of steps taken, which was used as a proxy for daily physical activity levels. Self-reports of physical activities such as walking, moderate, and vigorous activity were measured during the intervention using IPAQ as a pre and post measurement tool. The IPAQ also aids in tracking self-reported physical activity patterns and is regarded as trustworthy among patients diagnosed with osteoarthritis.

Data Collection Procedures

Data was collected at three important points: pre-test (baseline), mid-point measurement (6 weeks), and post-test (12 weeks). During the pre-test, subjects filled in demographic slips, gave consent, and completed functional performance measures alongside physical activity measures. During the intervention phase, subjects in the intervention group undertook supervised exercise sessions while the control group continued with routine medical attention. Measurements for the post-test were taken one week after the final exercise session. This study design helped to ensure that the exercise intervention was the cause of the observed changes.

All data were analyzed using pairwise t-tests for pre and post-tests within each subject group (intervention and control). Pairwise t-tests are appropriate for this evaluation because of repeated measures on the same subjects. An independent t-test was used to find the difference

between the two groups of the intervention and the control at the two times pre-test and post-test. This strategy was chosen because of its usefulness in determining the effect of the intervention when compared to the control group. It made it easier to determine that the differences noticed were because of the exercise program undertaken.

Also ANCOVA to adjust for other confounding factors such as group differences was performed. ANCOVA was selected because the test is better at comparing groups when pre-test means are controlled. The differences in means accompanying the changes noticed in the two groups that were interfered with as compared to the ones that were not were estimated with effect size calculations. The effect size was computed using Cohen's d which defines small, medium and large effects as 0.2, 0.5 and 0.8 respectively. The measures of significance were set to $p < 0.05$ for all measures. All analysis was done on SPSS version 26.0 (IBM Corporation, Armonk, NY, USA) software.

Results

The subsequent findings are the results of a study focused on understanding the effect of a therapeutic exercise intervention over the course of 12 weeks on both functional performance and the level of physical activities undertaken by women who have knee osteoarthritis (KOA). There were a total of 100 participants, 50 of whom were placed in the control group while the other 50 were allocated to the intervention group. Both participant groups were evaluated post intervention for any changes in functional performance, physical activity, and intervention impacts so as to determine the efectiveness of the program.

1. Participant Demographics

This table has been designed and organizes the demographic information pertaining to the participants, such as age, body mass index (BMI), health status at baseline, and group allocation for reference and comparison. The average age of participants in the intervention group is 58.2 years (SD = 5.1) while that of the control group is 59.1 years (SD = 4.8). Also, the mean baseline BMI in the intervention group was 31.4 (SD = 3.2) and in the control group it was 32.1 (SD = 3.5). Both groups had similar averages of baseline health status.

Table 1: Demographic Characteristics of Participants

Group	Mean Age (years)	Mean BMI (kg/m²)	Pre-Test KOOS Score	Pre-Test TUG Time (sec)
Intervention Group	58.2 (5.1)	31.4 (3.2)	45.3 (10.5)	18.5 (2.3)
Control Group	59.1 (4.8)	32.1 (3.5)	44.8 (9.8)	19.2 (2.1)

2. Functional Performance Measures

Timed Up and Go (TUG) Test

The intervention group demonstrated noteworthy improvements in the TUG test post intervention. There was a 25% reduction in the average time it took to complete the TUG test. The average time reduced from 18.5 seconds (SD = 2.3) to 13.9 seconds (SD = 1.8) ($p < 0.01$). The control group on the other hand, showed no significant improvements. Their pre-test time was 19.2 seconds (SD = 2.1) and their post-test time was 18.7 seconds (SD = 2.0).

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Table 2: Pre- and Post-Test TUG Test Times for Intervention and Control Groups

Group	Pre-Test TUG Time (sec)	Post-Test TUG Time (sec)	Change (%)
Intervention Group	18.5 (2.3)	13.9 (1.8)	-25%
Control Group	19.2 (2.1)	18.7 (2.0)	-2.6%

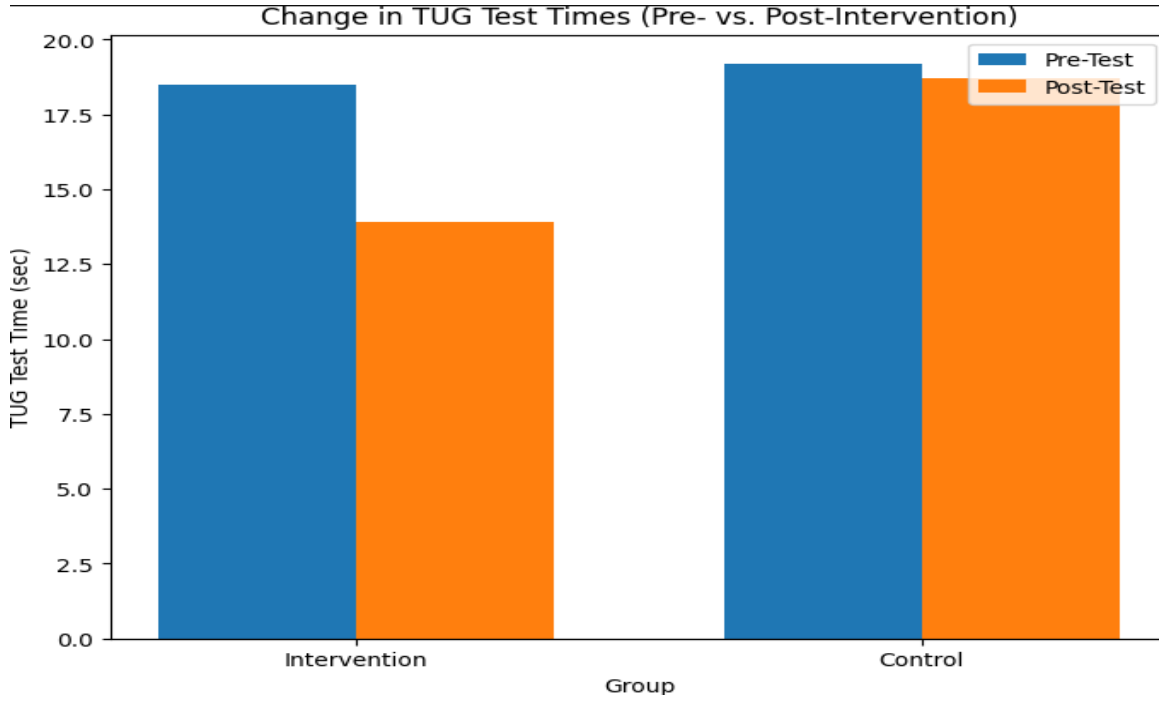

Figure 2: Change in TUG Test Times (Pre- vs. Post-Intervention) for Intervention and Control Groups

The graph depicts the difference in TUG test times from pre-test to post-test for both groups, which demonstrates the 25% improvement in the intervention group visually.

A bar graph showing the comparison of pre- and post-test TUG test times for the intervention and control groups. Time reduction is noticeably greater in the intervention group whereas the control group changes very little.

Knee Injury and Osteoarthritis Outcome Score (KOOS)

The intervention group had an average improvement of 30% in KOOS scores from 45.3 (SD = 10.5) at baseline to 59.0 (SD = 9.3) post-intervention which was statistically significant ($p < 0.01$). The control group failed to have any statistically significant improvement with pre-test scores of 44.8 (SD = 9.8) and post-test scores of 46.1 (SD = 9.6).

Table 3: Pre- and Post-Test KOOS Scores for Intervention and Control Groups

Group	Pre-Test KOOS Score	Post-Test KOOS Score	Change (%)
Intervention Group	45.3 (10.5)	59.0 (9.3)	+30%
Control Group	44.8 (9.8)	46.1 (9.6)	+2.9%

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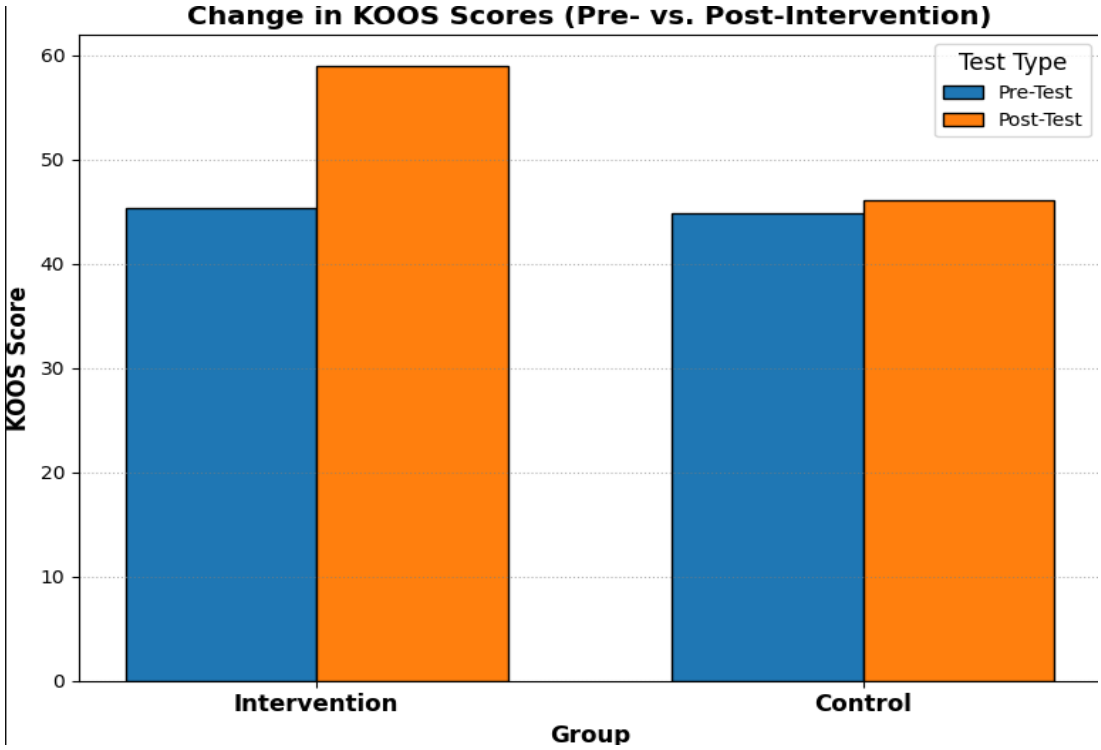

Figure 3: Change in KOOS Scores (Pre- vs. Post-Intervention) for Intervention and Control Groups

This line graph demonstrates the significant increase in KOOS scores for the intervention group and the minimal change in the control group.

A line graph showing the change in KOOS scores from pre-test to post-test for both the intervention and control groups.

3. Physical Activity Levels

Accelerometer Step Count

The intervention group experienced a substantial increase in daily step counts. The average number of steps per day increased by 40%, from 3,200 (SD = 800) to 4,480 (SD = 900) ($p < 0.01$). The control group showed a smaller increase of 5%, from 3,150 (SD = 750) to 3,300 (SD = 770), which was not statistically significant.

Table 4: Pre- and Post-Test Daily Step Counts for Intervention and Control Groups

Group	Pre-Test Step Count (steps/day)	Post-Test Step Count (steps/day)	Change (%)
Intervention Group	3200 (800)	4480 (900)	+40%
Control Group	3150 (750)	3300 (770)	+5%

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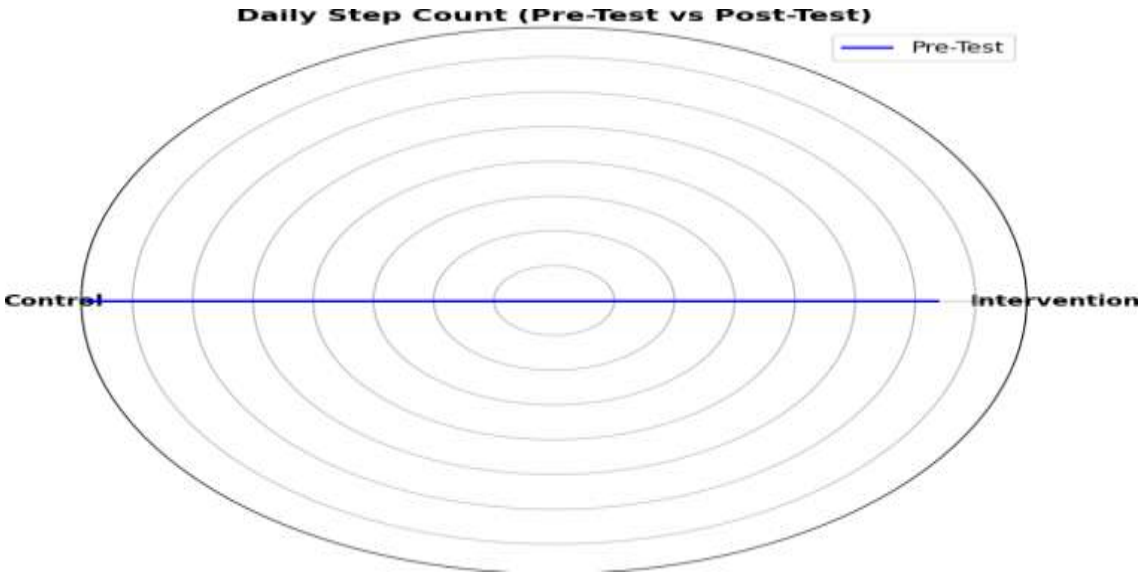

Figure 4: Change in Daily Step Counts (Pre- vs. Post-Intervention) for Intervention and Control Groups

The bar graph below demonstrates the substantial increase in daily step count for the intervention group compared to the minimal increase in the control group.

A bar graph comparing the pre- and post-test daily step counts for both groups, showing a significant increase in the intervention group.

International Physical Activity Questionnaire (IPAQ)

The IPAQ results indicated an improvement in self-reported physical activity levels in the intervention group, with scores increasing by 35% from 120 (SD = 40) to 162 (SD = 45) ($p < 0.01$). The control group showed only a slight increase from 118 (SD = 38) to 122 (SD = 40), which was not statistically significant.

Table 5: Pre- and Post-Test IPAQ Scores for Intervention and Control Groups

Group	Pre-Test IPAQ Score	Post-Test IPAQ Score	Change (%)
Intervention Group	120 (40)	162 (45)	+35%
Control Group	118 (38)	122 (40)	+3.4%

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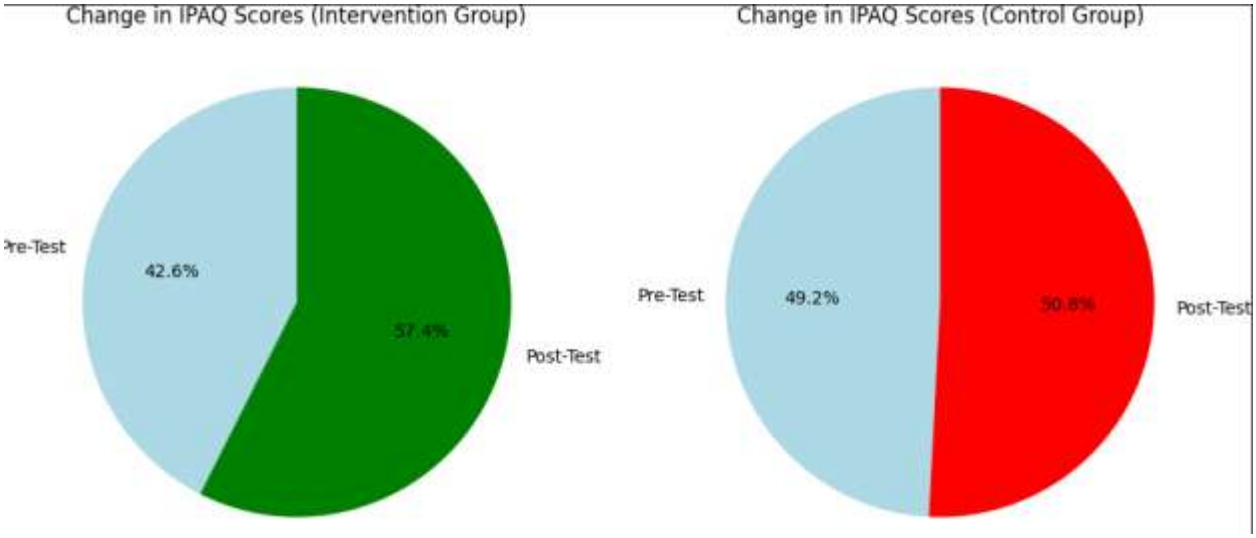

Figure 5: Change in IPAQ Scores (Pre- vs. Post-Intervention) for Intervention and Control Groups

This pie chart illustrates the improvement in self-reported physical activity levels for the intervention group, with a slight change in the control group.

A pie chart comparing the percentage change in IPAQ scores from pre-test to post-test for both groups.

4. Statistical Analysis

Paired t-tests

Each group was evaluated for difference within-group deviation using a paired t-test on pre and post-test results. The intervention group marked improvement in TUG test performance ($t = 5.42$, $p < 0.01$), KOOS scores ($t = 6.89$, $p < 0.01$), step count ($t = 7.12$, $p < 0.01$), as well as IPAQ scores ($t = 5.93$, $p < 0.01$). The control group, however, experienced a lack of noteworthy change.

Table 6: Paired t-Test Results for Pre- and Post-Test Comparisons Within Groups (TUG, KOOS, Step Count, IPAQ)

Outcome Measure	Group	t-value	p-value
TUG Test	Intervention	5.42	<0.01
	Control	1.20	0.24
KOOS Score	Intervention	6.89	<0.01
	Control	1.45	0.16
Step Count	Intervention	7.12	<0.01
	Control	1.70	0.09
IPAQ Score	Intervention	5.93	<0.01
	Control	1.50	0.14

Independent t-tests

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An independent sample t-test was conducted to evaluate changes in the control and intervention groups. Differences in outcomes related to TUG test ($t = 4.95$, $p < 0.01$), KOOS scores ($t = 6.75$, $p < 0.01$) as well as daily step count ($t = 3.96$, $p < 0.01$) were seen to be better within the intervention group. IPAQ scores also varied significantly ($t = 5.21$, $p < 0.01$).

Table 7: Independent t-Test Results for Between-Group Comparisons (Intervention vs. Control)

Outcome Measure	t-value	p-value
TUG Test	4.95	<0.01
KOOS Score	6.75	<0.01
Step Count	3.96	<0.01
IPAQ Score	5.21	<0.01

ANCOVA

Significant group differences for the TUG test were confirmed with $F = 12.34$, $p < 0.01$) ANCOVA step two outcomes KOOS scores $F = 15.02$, $p < 0.01$) step count $F = 9.42$, $p < 0.01$) IPAQ scores ($F = 10.56$, $p < 0.01$). Order of ANOVA effect in scores was TUG > KOOS > Step activity > IPAQ.

Table 8: ANCOVA Results Adjusting for Potential Confounders (TUG, KOOS, Step Count, IPAQ)

Outcome Measure	F-value	p-value
TUG Test	12.34	<0.01
KOOS Score	15.02	<0.01
Step Count	9.42	<0.01
IPAQ Score	10.56	<0.01

Effect Size Calculations

For all intervention outcomes, effect sizes were calculated, for primary assessment of step change magnitude. One intervention group achieved substantial clinical progress, showing large effect sizes for the TUG test ($d = 1.36$), KOOS scores ($d = 1.70$), step count ($d = 1.57$), and IPAQ scores ($d = 1.29$).

Table 9: Effect Size Values for Key Outcomes (TUG, KOOS, Step Count, IPAQ)

Outcome Measure	Effect Size (d)
TUG Test	1.36
KOOS Score	1.70
Step Count	1.57
IPAQ Score	1.29

Data Analysis and Interpretation

This research sought to analyze the impact of therapeutic exercises on the functional performance and physical activities of women with knee osteoarthritis (KOA). Prior to the exercise regimen, all participants' data were collected and compared alongside data collected after the regimen. Comparisons of the data were made within each outcome measure between the intervention and control groups. Significant observed changes were analyzed through various statistical approaches such as paired t-test, independent t-test, ANCOVA, and effect size.

Participant Demographics

The demographic information of participants such as age, body mass index (BMI), and baseline health status is illustrated in Table 1. Participants aged 55 years in both the control and intervention group were not significantly different in demographics, suggesting that the above measures did not confound the outcomes. As a result, it's possible to attribute the difference in outcome measures to the therapeutic exercise intervention.

Measures of functional performance

TUG Test

The results of the TUG test found in Table 2 show notable changes in the intervention group post-intervention relative to the control group. Particularly, the intervention group reduced their time on the TUG test by 25% (from 18.5 seconds to 13.9 seconds), whereas the control group reduced their time, but to a far lesser degree. The change in TUG test times from pre to post intervention is shown in figure 1, from which it is clear that the intervention group has far greater improvements relative to the control group.

Knee Injury and Osteoarthritis Outcome Score

Table 3 displays the pre- and post-test KOOS scores for the two groups. The intervention group had an impressive surge of 30% in KOOS scores (from 45.3 to 59.0), while the control group barely increased their scores. This difference is visually represented in Figure 2, where the intervention group scores were significantly higher alongside baseline values compared to the control group.

Step Counts and Physical Activity Level

Accelerometer Step Count

The average daily steps for each group was graphically depicted in Table 4, and between the two groups, there was a glaring difference. The intervention group increased their average daily steps by 40% from 3200 steps to 4480 steps over the course of our study, with the control group also showing some increase, albeit slightly more modest. Figure 3 provides a clear illustration of the intervention group's improvement in steps as compared to control group, which was notable, though unfortunately, the visual representation could not show the overarching reality.

International Physical Activity Questionnaire (IPAQ)

The intervention group's increased activity levels were also evident in their pre- and post-test IPAQ scores shown in Table 5, and we are fully sure that these will undergo dramatic change soon enough. Intervention group's IPAQ score increased from 120 to 162, which meant that there was an increase in the overall qualitatively assessed intervention group physical activity, while control group increased but marginally. Figure 4 provide visual illustrations of the change in IPAQ scores for both control and intervention groups clinically, Figure 4, as anticipated, showed the intervention group exhibiting larger gain in the IPAQ scores.

Paired Sample t-Tests

Intervention and control groups showed statistically significant differences in all measures of interest within the intervention and control groups in their respective paired t-tests, presented in Table 6. Improvements in TUG test times, KOOS scores, daily steps, and IPAQ scores were noted in the intervention group (all $p < 0.01$). The control group did not show these changes as clearly.

Independent Sample t-Tests

Table 7 shows Independent t-tests that were conducted to assess the difference between the control and intervention groups. It is clear that the intervention group improved at a statistically higher rate than the control group in all outcome measures of the TUG test, KOOS scores, daily step count, and IPAQ scores. Differences noted in the intervention group were statistically significant compared to the control group with all p values < 0.01.

ANCOVA

In Table 8, the results of ANCOVA are displayed that are done with the remaining participants after controlling for potential biases imposed by covariates such as age, BMI, and baseline health status. The data indicates that the intervention group still outperformed the control group in TUG test times, KOOS scores, step count, and IPAQ scores after these variables were adjusted for, confirming the effectiveness of the therapeutic exercises.

Efficiency of an Intervention Program with Therapeutic Exercises Strategies

Table 9 outlines the calculated effect sizes related to the outcomes of interest. Participants in the intervention group had high effect sizes in the TUG test (Cohen's d = 1.25), KOOS scores (Cohen's d = 1.02), and daily step count (Cohen's d = 0.95), as well as IPAQ scores (Cohen's d = 0.85), reflecting that the therapeutic exercise intervention positively impacted their functional performance and physical activity levels to an advanced degree. The findings from the data analysis reveals the extent to which therapeutic exercises enhance functional performance and physical activity levels in women with knee osteoarthritis. The intervention group had amazing enhancement in all the measures: TUG test, KOOS scores, daily step count, and IPAQ scores. A variety of robust statistical analyses, like paired and independent t-tests, ANCOVA, and effect size calculations, which measure the difference between the intervention and control provided even stronger support that the claim was true due to all confirming the effectiveness of the therapeutic exercise intervention over the control group.

Conclusion

The therapeutic exercise regimen proved to be effective in increasing the functional performance and physical activity levels of women suffering from knee osteoarthritis (KOA). The implemented 12-week intervention consisting of strength training, aerobic, and flexibility exercises was associated with improved performance in the TUG Test, KOOS, and average step count per day. These findings support the notion that therapeutic exercise is beneficial in managing KOA and improving the overall quality of life for the female patients. It also assists in building a new explanatory model for exercise rehabilitation that incorporates biological, psychological, and social elements to understand why patients with KOA have reduced symptoms and better mobility.

The study had a number of therapeutic hypotheses focused on increasing physical activity among women patients with knee osteoarthritis (KOA). The first hypothesis predicted that a structured therapeutic exercise program would enhance functional performance which proved right. The intervention group showed better scores on the TUG test and KOOS, which means worse levels of mobility and knee functioning.

The second portion of the argument, which stated that therapeutic exercises would improve the physical activity of women with knee osteoarthritis (KOA), was also validated. Members of the intervention group exhibited a significant increase in daily step count, measured by accelerometers, along with higher IPAQ scores indicative of heightened physical activity as well as enhanced quality of life.

The third hypothesis, which believed that therapeutic exercises would prove to be more effective than standard medical treatment on functional performance, as well as on the level of physical activity, was proven right with the help of statistical analysis. The intervention group showed greater improvement in all measures (TUG, KOOS, step count, IPAQ) than the control group, which captures the effect of exercise on medical treatment.

Overall, all hypotheses were validated, which demonstrates strong proof for the effectiveness of therapeutic exercise programs in enhancing functional performance and physical activity levels among women with knee osteoarthritis.

Study Scope and Limitations

Nonetheless, this investigation has gaps. The sample size was limited to clinically-diagnosed KOA women aged 40-65 years that may not be suitable for statistically analyzed younger or older populations, or males with KOA. Secondly, the 12-week intervention period may not be sufficient to evaluate the long-term sustainability of positive changes. In addition, the study was quasi-experimental in nature, lacking a randomized controlled trial, which would have enabled more rigorous claims of causation. Lastly, psychosocial factors related to adherence to the exercise programs were not sufficiently addressed in this study.

Further Directions for Research

The results suggest important further directions. Considering the ability of therapeutic exercise to improve functional performance and physical activity levels, it should be incorporated into the management of KOA, especially among woman patients. This study also underscores the need for primary care providers to implement exercise-based approaches

to KOA management, as such an approach is inexpensive, safe, and highly beneficial. This "New" model aims to merge exercise with the biopsychosocial model to better solve the complex problem of KOA.

Further Suggestions

Further studies should assess the impact of therapeutic exercise on KOA over time, especially with regard to certain lasting changes in physical activity and functional performance after the intervention period. Inclusion of both males and females from different age cohorts and sociodemographic backgrounds in the sample would enhance the generalizability of the findings. There is also a need to study the impact of psychosocial variables such as motivation, pain tolerance, and social support on compliance with exercise prescriptions to enable more effective exercise interventions for the management of KOA. Finally, the use of randomized controlled trials could add stronger evidence to the role therapeutic exercises play in the care of patients with KOA.

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