Original Article

Effect of Multimodal Physiotherapy Approach on Grade I and Grade II Knee Osteoarthritis in Overweight Females

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Abstract

Background: Knee osteoarthritis is a degenerative condition causing pain and disability, especially in overweight females. Conventional physiotherapy mainly relieves symptoms, while a multimodal physiotherapy approach addresses both physical and psychosocial aspects.

Materials and Methods: A randomized experimental study was conducted on 60 overweight females, aged 40 to 60 years, diagnosed with grade I or grade II knee osteoarthritis. Participants were randomly allocated into two groups, with 30 subjects in the experimental group (group A) and 30 subjects in the control group (group B). All participants had a body mass index ranging from 25 to 29.9 kg/m^2. Outcomes were assessed using validated scales for pain, function, body mass index, and adherence.

Conclusion: Between groups, Group A had higher adherence ($p < 0.001$) and lower post-intervention NPRS ($p < 0.001$) and WOMAC scores ($p < 0.001$) than Group B.

Keywords: Knee osteoarthritis, Multimodal physiotherapy, Biopsychosocial model, Overweight females, Adherence to treatment

Introduction

Arthritis is inflammation within the joints, characterized as a chronic, age-related, degenerative condition. [1, 2] Osteoarthritis is a joint degenerative disease leading to loss of articular cartilage, which normally reduces friction during movement. [3] Individuals with knee osteoarthritis experience mobility impairments that limit activities of daily living and reduce quality of life. [4]

The knee, the largest synovial joint in humans, comprises bones including the distal femur, proximal tibia, and patella; cartilage such as the meniscus and articular cartilage; ligaments; infrapatellar fat pad; and synovium, which produces synovial fluid to lubricate and nourish cartilage. [5] Muscles

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including quadriceps femoris, popliteus, biceps femoris, semitendinosus, and semimembranosus facilitate flexion, extension, rotation, and locking and unlocking of the joint. [6] Cruciate ligaments, menisci, and other soft tissues provide stability, shock absorption, load distribution, and cartilage nutrition, with meniscal injuries contributing to osteoarthritis. [7] Clinically, knee osteoarthritis presents with pain, morning stiffness, swelling, crepitus, and functional limitations. [8, 9] Radiographs, including anteroposterior, lateral, and skyline views, alongside the Kellgren and Lawrence grading system, classify severity from grade 0 to grade IV. [6, 7, 10] Osteoarthritis progresses gradually, with worsening symptoms over time. [5]

The etiology of knee osteoarthritis is multifactorial, including increased tibiofemoral forces, altered femoral curvature, bone marrow lesions, cartilage loss, joint space narrowing, and tibial plateau compression. [7] Mechanical stress and inflammation drive cartilage erosion via matrix metalloproteinases and A Disintegrin and Metalloproteinase with Thrombospondin motifs, leading to chondrocyte loss, subchondral bone remodeling, and synovial inflammation. [14, 15] Age, gender, genetics, metabolic syndrome, trauma, and lower limb malalignment influence disease onset and progression. [5, 7, 16] Advancing age alters cartilage properties, reduces hydration, and promotes catabolic pathways, while women exhibit higher incidence due to smaller knee sizes, higher Q angles, gait variations, and postmenopausal hormonal changes. [14, 16, 17]

Overweight individuals are at higher risk, as obesity increases mechanical loading and triggers metabolic changes, including altered adipokine production and systemic inflammation, affecting cartilage, subchondral bone, menisci, synovium, and infrapatellar fat pad. [8, 14, 16, 18, 21] Fat mass plays a greater role in women, accelerating disease progression through mechanical and biological pathways. [18, 21]

Globally, osteoarthritis affects approximately 100 million people and is the twelfth leading cause of disability. [1, 19] In India, prevalence rose from 23.46 million in 1990 to 62.35 million in 2019, with higher rates among women (51%) than men (33.09%). [1, 14] Knee osteoarthritis contributes significantly to disability-adjusted life years and years lived with disability, particularly in aging populations. [4, 20]

Non-surgical management is recommended as first- and second-line treatment, reserving joint replacement for refractory cases. [11, 12] First-line interventions include lifestyle modification, physical therapy, over-the-counter medications, and assistive devices, while second-line treatments involve prescription medications, intra-articular injections, and specialized physical interventions. [11] Physiotherapy integrates exercise therapy, manual therapy, electrotherapy, patient education, and weight management. [11, 22, 23]

Adherence is critical for effective outcomes, yet patients often face barriers such as low motivation, time constraints, environmental limitations, and lack of understanding. [11, 24, 25] Strong therapeutic alliances, individualized care, and patient education improve adherence, enhancing pain reduction, functional improvement, and long-term joint health. Multimodal physiotherapy addresses both physical and psychosocial factors, promoting consistent participation and better outcomes. [23, 26]

The biopsychosocial model supports individualized care by integrating physical, psychological, and social factors. [25, 26] Multimodal physiotherapy, combining exercise, manual therapy, education, and other interventions, systematically targets all components of knee osteoarthritis, improving pain, function, balance, and quality of life. [13, 22, 27, 28, 29, 30, 31] Despite evidence for multimodal interventions, few studies focus on overweight females, a high-risk population due to mechanical, hormonal, and metabolic factors. [4, 23] There is a need for protocols that are personalized, emphasize adherence, and address the multifactorial pathology of knee osteoarthritis. This study aims to develop and evaluate a multimodal physiotherapy protocol for overweight females, targeting anatomical, functional, and psychosocial impairments, thereby addressing a critical gap in the literature. [4]

Methods

Research Design: Completely Randomized Design (Two group simple randomized experimental designs).

Research Setting

1. OPD, based in physiotherapy department of Guru Nanak Hospital, Amritsar
2. Flying wings physiotherapy and rehabilitation Centre, Amritsar
3. OPD, based in physiotherapy department of Khalsa College, Amritsar

Sample Size

$$\text{Sample size} = \frac{2SD^2(1.96 + 0.84)^2}{d^2} = 68.06$$ [40]

60 participants were divided into two groups, with 30 in the control group and 30 in the experimental group. Outcomes were assessed by an independent assessor blinded to group allocation

Sampling method: Participants were allocated using simple random sampling by a lottery (chit) method.

Inclusion Criteria

1. Age: 40 to 60 years.
2. Overweight females with body mass index (BMI) ≥ 25 to 29.9 kg/m^2.
3. GRADE1 and GRADE 2 knee osteoarthritis (Pre-diagnosed).
4. Women complaining of pain since 3 months.
5. Subjects taken were fluent in english language.

Exclusion Criteria

1. History of knee ligament or meniscal injury.
2. Recent fractures in the knee joint.
3. History of knee joint surgery or corticosteroid injections within a specified timeframe.
4. Presence of systemic, metabolic, infectious, or neuromuscular diseases that may affect the knee joint.
5. Pregnancy or lactation
6. Diagnosis of ankylosing spondylitis, rheumatoid arthritis, osteomalacia, Paget's disease, or other conditions that may interfere with the study objectives.
7. Participation in other limb strengthening programs during the study period.
8. Patient has not taken any painkillers in the last 3 months.
9. Pain medications are not permitted within 4 weeks of the protocol timeframe.
10. Patients having back pain, ankle pain, hip pain.
11. Patients having radiculopathy and neuropathy.

Variables

Dependent Variables:

- BMI
- NPRS
- WOMAC
- ADHERENCE RATING SCALE

Independent Variables

- Conventional physiotherapy
- Multimodal physiotherapy program

Equipment used: Stadiometer and Weighing machine.

Data Collection: Data is collected at baseline and after 4 weeks physiotherapy session.

Statistical Analysis: Independent t-tests

Dependent t-test

Procedure: Participants were randomly assigned to a control group (conventional treatment) or an intervention group (multimodal physiotherapy protocol), each consisting of 30 participants. On the first day, all participants underwent initial assessments including knee history, general musculoskeletal assessment, Western Ontario and McMaster Universities Osteoarthritis Index, Numerical Pain Rating Scale, Adherence Rating Scale, and Body

Mass Index. The intervention group also received a comprehensive biopsychosocial assessment and individualized treatment. They attended weekly 30-minute, patient-specific educational sessions for four weeks. At the end of the four-week period, all participants were reassessed using the same outcome measures to evaluate treatment effectiveness.Tables given below represents the exercise protocol followed by the control and intervention groups, detailing the proper dosage, duration, and frequency.

Physiotherapy for Control Group

1. Knee Isometric Exercises

- **Description:** Isometric contractions of the quadriceps muscle.
- **Sets/Repetitions/Hold Time:** 3 sets of 10 repetitions, each held for 10 seconds.
- **Rest:** 2 seconds between repetitions, 30 seconds between sets.
- **Duration:** Performed three times per week for 4 weeks.

2. Self-Stretching Exercises

- Muscles Targeted:
  - Hamstrings
  - Quadriceps Femoris
  - Gastrocnemius-Soleus
- **Protocol:** Single set of 3 repetitions for each muscle, with each repetition held for 30 seconds.
- **Rest:** 30 seconds between repetitions.
- **Duration:** Performed three times per week for 4 weeks.

3. Transcutaneous Electrical Nerve Stimulation (TENS)

- **Frequency:** 100–150 Hz
- **Pulse Width:** 100 to 500 milliseconds
- **Intensity:** 12–30 milliamperes (mA)
- **Application Time:** 15 minutes per session.
- **Duration:** Performed three times per week for 4 weeks.

4. Precautionary Advice (Dos and Don'ts)

- **Description:** Education session on safety measures and lifestyle modifications for managing knee osteoarthritis.
- **Frequency:** One session during the 4-week intervention.
- **Duration:** Conducted once within the 4-week period.

Physiotherapy for experimental group:

1. Individualized Treatment Based on Assessments

- **Description:**Treatment was customized for each patient based on general musculoskeletal and biopsychosocial assessments. The treatment was given according to the patient centric approach that is individualized care was given, and exercises and modalities were selected from a pool of nine, so not all participants received the full set
- **Frequency:** One session
- **Timing:** Administered at baseline (before starting intervention)

2. Patient Education Sessions

- 1st Session (Week 1):
  - **Content:** Introduction to knee osteoarthritis, causes, joint changes, physiotherapy role, precautions, and protocol significance.
  - **Duration:** 30 minutes
- 2nd Session (Week 2):
  - **Content:** Motivation, correcting misconceptions, managing unrealistic expectations.
  - **Duration:** 30 minutes
- 3rd Session (Week 3):
  - **Content:** Progress discussion, addressing false expectations, accurate information reinforcement.
  - **Duration:** 30 minutes

- 4th Session (Week 4):
  - **Content:** Recap and forward guidance: importance of activity, healthy weight, lifestyle, ergonomics, follow-ups, and dos/don'ts.
  - **Duration:** 30 minutes
- **Frequency:** One session per week for 4 weeks

3. Aerobic Exercise – Pedometer Cycling

- **Description:** Patient-specific cycling (self-selected speed and seat height)
- **Sets/Repetitions:** 3 sets of 50 repetitions
- **Rest:** 30 seconds between sets
- **Frequency:** Three times per week for 4 weeks

4. Progressive Resistance Exercise (PRE)

- Muscle Groups Targeted:
  - Knee extensors/flexors
  - Hip extensors/flexors/abductors/external rotators
  - Ankle dorsiflexors and plantar flexors
- **Sets/Repetitions:** 3 sets of 10 repetitions, each held for 10 seconds
- **Rest:** 2 seconds between repetitions, 30 seconds between sets
- **Frequency:** Three times per week for 4 weeks

5. Therapist-Assisted Stretching Exercises

- Muscles Targeted:
  - Hamstrings
  - Quadriceps femoris
  - Gastrocnemius-Soleus
- **Protocol:** Single set of 3 repetitions with a 30-second hold
- **Rest:** 30 seconds between repetitions
- **Frequency:** Three times per week for 4 weeks

6. Neuromuscular Training

- Exercises:
  - Frenkel Exercises: Axial turning, stair climbing, side-stepping [30]
  - Standing balance on an unstable surface
- **Repetitions (Frenkel):** 3 sets of 15 repetitions
- **Repetitions (Balance):** 3 sets of 3 repetitions with a 60-second hold
- **Rest (Balance):** 2 seconds between repetitions and 30 seconds between sets
- **Rest Between Frenkel Sets:** 120 seconds between repetitions and between sets
- **Frequency:** Three times per week for 4 weeks

7. Maitland Mobilization

- Joints Targeted:
  - Patellofemoral
  - Tibiofemoral
  - Distal tibiofibular
  - Talocrural
  - Talocalcaneal
  - Hip joint
- **Grade:** I and II mobilizations
- **Protocol:** 6 repetitions, 3 sets
- **Frequency:** Three times per week for 4 weeks

8. Soft Tissue Manipulation (Massage)

- **Technique:** Effleurage [31]
- **Areas Covered:**
  - Peripatellar tissue
  - Quadriceps, hamstrings, hip adductors
  - Gastrocnemius-Soleus
  - Fascia of thigh and leg musculature
- **Duration:** 3 to 5 minutes per session
- **Frequency:** Three times per week for 4 weeks

9. Kinesio Taping (KT)

- Application Details:
- **1st Strip (Y):** Over quadriceps; tails wrap patella medially and laterally with 50% tension during max knee flexion.
  - **2nd Strip (Y):** From tibial tuberosity to inferior pole of patella; applied at 90° knee flexion.
  - **3rd Strip (I):** Applied mediolaterally over patella at 30° knee flexion with 50% tension.

- **Application Schedule:**
  - Applied **twice weekly** (Friday and Monday)
  - **Weaning off:** Monday and Wednesday

Outcome Measure

Primary outcomes for this study included pain, body mass index (BMI), adherence, functional mobility, quality of life, and activities of daily living. Pain was assessed using the Numeric Pain Rating Scale (NPRS) (0-10) [35]. Functional mobility, quality of life, and daily activities were measured with the modified Western Ontario and McMaster University (WOMAC) Osteoarthritis Index (Likert 0-4) [36]. Adherence was evaluated using a specific scale (0-4, 0=good) [24, 37]. BMI was calculated as weight (kg) / height (m)2; overweight was defined as BMI ≥25 to 29.9 kg/m^2 [34]. All measures were taken pre- and post-intervention.

Data Analysis

Between the group comparison:

Unpaired T Test	Comparison			
	ADHERENCE SCALE			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	3.90	3.70	0.00	3.90
S.D.	0.305	0.466	0.000	0.305
Number	30	30	30	30
Mean Difference	0.20		3.90	
Unpaired T Test	1.966		70.007	
P value	0.0540		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 1. Between the group Comparison for adherence

Unpaired T Test	Comparison			
	WEIGHT (Kg)			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	71.37	69.33	68.80	69.34
S.D.	5.732	5.441	5.455	5.410
Number	30	30	30	30
Mean Difference	2.03		0.54	
Unpaired T Test	1.409		0.383	
P value	0.1642		0.7034	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Not-Significant	

Table No. 2. Between the group Comparison for Weight

Unpaired T Test	Comparison			
	BMI			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	27.13	26.93	26.23	26.94
S.D.	1.354	1.151	1.179	1.136
Number	30	30	30	30
Mean Difference	0.20		0.71	
Unpaired T Test	0.606		2.385	
P value	0.5468		0.0203	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 3. Between the group Comparison for BMI

Unpaired T Test	Comparison			
	NPRS			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	5.10	4.80	3.07	4.87
S.D.	0.607	0.664	0.785	0.571
Number	30	30	30	30
Mean Difference	0.30		1.80	
Unpaired T Test	1.825		10.155	
P value	0.0731		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 4. Between the group Comparison for NPRS

Unpaired T Test	Comparison			
	WOMAC			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	34.93	34.90	15.83	33.27
S.D.	10.544	10.420	5.718	10.342
Number	30	30	30	30
Mean Difference	0.03		17.43	
Unpaired T Test	0.012		8.080	
P value	0.9902		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 5: Between the group Comparison for WOMAC

Results

Out of the 60 subjects recruited in the preliminary study, 30 subjects in each group completed the study program. Between the groups, Group A had higher adherence ($p < 0.001$) and lower post-intervention NPRS ($p < 0.001$) and WOMAC scores ($p < 0.001$) than Group B. The overall significance for the chosen factor, the multimodal physiotherapy approach, was found to be statistically significant. Therefore, the administered intervention protocol, consisting of a combination of biomedical and biopsychosocial approaches, was found to be significantly effective in the management of knee osteoarthritis in overweight females, leading to reductions in pain, lower body mass index(BMI), improved adherence, and reduced Western Ontario and McMaster University (WOMAC) Osteoarthritis Index scores

Discussion

This study assessed the effectiveness of a multimodal physiotherapy protocol, combined with a biopsychosocial approach, in managing knee osteoarthritis among overweight females. Traditional physiotherapy often emphasizes symptom management and follows a biomedical model, overlooking psychological and social influences. The biopsychosocial model addresses this gap by integrating physical, emotional, and social aspects into patient care. It encourages individualized care through better communication and therapeutic alliance between patient and therapist [25].

Previous studies have highlighted poor adherence to treatment protocols as a barrier to successful outcomes despite the proven benefits of exercise and electrotherapy [23, 22]. Psychological factors such as anxiety and depression are also associated with increased pain and disability in early osteoarthritis, underlining the importance of a more holistic treatment strategy [32]. However, clinical application of the biopsychosocial model faces challenges like limited training, unclear roles, and patient expectations [33].

The findings of this study align with existing evidence showing that multimodal interventions improve pain, physical function, balance, and overall quality of life in patients with knee osteoarthritis [4, 13, 28]. Statistical analysis demonstrated significant improvements in body mass index, pain scores, functional outcomes, and adherence levels in the intervention group receiving multimodal care compared to the control group.

In conclusion, this study supports the implementation of a multimodal physiotherapy protocol grounded in the biopsychosocial model. This approach is effective in addressing the complex nature of knee osteoarthritis in overweight females and has the potential to improve patient outcomes while reducing the broader healthcare burden.

Limitations

1. Small sample size.
2. Small geographical area.
3. Dietary advice and lifestyle modification for weight loss management.

Future Scope

1. Long term follow up.
2. This study only focuses on females but male counterparts can also be explored.

Conflict of Interest: None

Source of Funding: Self

Ethical Clearance: A written informed consent was obtained from the patient, and the study was performed with the approval of ethical committee at Khalsa college Amritsar. Ref no IEC/KCA/PT/2024/02 Dated:15/01/24.

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