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Effect of Exergaming Versus Standard Care Physiotherapy on Pain, Range of Motion and Function in Subjects with Knee Osteoarthritis

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ABSTRACT

BACKGROUND AND OBJECTIVE: Knee Osteoarthritis is a common degenerative condition in the elderly, causing pain, stiffness, and functional limitations. Standard physiotherapy is widely used to manage symptoms and improve mobility. Exergaming, an interactive exercise-based approach, is an emerging rehabilitation method with limited use in orthopedics. This study aimed to compare the effects of exergaming and standard care physiotherapy on pain, knee range of motion, and functional outcomes.

METHODS: A quasi-experimental study design. A total of 150 participants with clinically diagnosed knee osteoarthritis were randomly allocated into two groups. Group A (n=75) received exergaming intervention, while Group B (n=75) underwent standard care physiotherapy. Both groups received treatment for six weeks. Outcome measures were assessed pre- and post-intervention using the VAS for pain, Universal Goniometer for knee flexion range of motion, and WOMAC for functional status.

RESULTS: Baseline comparisons showed no significant differences between groups ($p>0.05$). Following six weeks of intervention, both groups demonstrated improvement; however, Group A showed significantly greater post-test improvements. Post-test VAS scores were lower in Group A (2.84 ± 0.75) compared to Group B (3.98 ± 0.77) ($p=0.001$). WOMAC scores improved more in Group A (19.18 ± 2.70) than in Group B (29.74 ± 2.56) ($p=0.0001$). Knee flexion range of motion was significantly higher in Group A (130.06 ± 3.35) compared to Group B (119.64 ± 3.44) ($p=0.0001$).

CONCLUSION: After Six weeks of training both the groups showed significant improvement. Exergaming Group was found to be more effective when compared to Standard Care Physiotherapy.

Keywords: *exergaming, standard care physiotherapy, virtual reality, knee*

osteoarthritis, transcutaneous electrical nerve stimulation, WOMAC, VAS.

INTRODUCTION

Osteoarthritis is a chronic degenerative joint disorder characterized by progressive loss of articular cartilage, alteration of subchondral bone, synovial inflammation, and the formation of osteophytes leading to pain and functional limitation.[1,2] According to W.H.O definition, Osteoarthritis is a disease of the entire joint involving the cartilage, joint lining, ligaments, and underlying bone, the breakdown of these tissues eventually leads to pain and stiffness. It is considered one of the most common causes of disability and affecting quality of life.[3]

Knee osteoarthritis is the most common form of arthritis and a major cause of pain and disability.[4] Globally, its prevalence is estimated to be around 20% in men and 41% in women, contributing to pain and reduced functional ability in nearly 20% of older adults. In India, osteoarthritis is the second most common condition, with a prevalence ranging from 22% to 39%.[5] Among individuals over 20 years of age, the incidence is reported as 203 per 10,000 people, with women showing a higher incidence than men.[6]

The functional knee joint comprises the distal femur, proximal tibia, and the patella articulations, two tibiofemoral compartments (medial and lateral) and the patellofemoral compartment, supported by menisci.[7] The stability of knee joint is maintained by ligamentous structures including collateral and cruciate ligaments. Quadriceps and hamstrings muscles act as dynamic stabilizers, contributing to joint stability and functional movement during daily activities.[8]

The causes of osteoarthritis are considered multifactorial, involving genetic, environmental, metabolic, and biomechanical factors. Osteoarthritis is categorized into primary and secondary types. Primary osteoarthritis has no identifiable cause (idiopathic), while secondary osteoarthritis results from an underlying joint condition that contributes to its degeneration.[9] The current evidence on risk factors for onset of knee osteoarthritis identified as a set of factors.

The risk factors of osteoarthritis can be divided into person level factors, including age, gender, obesity, genetics, diet and joint level factors including injury and abnormal loading of the joints.[10] Knee malalignment is the strongest predictor of progression of knee osteoarthritis.[11] The pathological process of knee osteoarthritis is initiated by catabolic factors , such as cytokines IL-6, IL-8 , matrix metalloproteinases , and heat shock proteins (HSPA1A)—act as measurable biomarkers for predicting the onset and progression of Osteoarthritis, with cartilage matrix degradation recognized as a key biological trigger of this degenerative process.

These alterations include subchondral bone sclerosis, cyst formation, and marginal osteophyte development due to bone alteration, leading to joint space narrowing and accelerated disease progression. Over time, synovial inflammation and capsular fibrosis involve the entire joint, leading to stiffness, pain, and functional limitation.[12]

Clinical Features of Osteoarthritis knee is characterized by a gradual onset of pain that worsens with activity and is relieved by rest. Pain commonly affects crucial functional activities such as walking and climbing stairs.[13]

Associated symptoms include crepitus, tenderness, swelling, and muscle weakness leading to reduced joint function.[14] The diagnosis of knee osteoarthritis is mainly clinical, supported by radiological and functional assessments.[15] Clinically, the American college of rheumatology criteria consider knee pain with morning stiffness, crepitus, bony tenderness, bony enlargement.[16]

Radiographically, features such as joint space narrowing, osteophyte formation, subchondral sclerosis, and cysts are assessed using the Kellgren-lawrence grading system.[17] Treatment of knee osteoarthritis relies on multimodal strategy, integrating

pharmacologic treatments, non-drug or conservative methods, and where necessary surgical options.[18]

Some researchers have demonstrated that physiotherapy interventions are effective in reducing pain and improving activity in people with knee pain.[19] Physiotherapy plays a central role, with interventions including therapeutic exercise and electrotherapy designed to alleviate pain, improve flexibility, build strength and enhance overall functional ability.[20] Manual therapy aimed at decreasing tightness of the lateral structures and are individually responsible for the improvement of the joint.[21]

Recent studies showed that traditional exercises such as Pilates, aquatic exercise (AE) and muscle strengthening were found to be significantly effective in alleviating Knee Osteoarthritis-related symptoms. Therapeutic effect of exercise varies by type of exercise (such as resistance training [RT] and aerobics).[22] Exercise therapy forms the keystone of rehabilitation and includes range of motion exercises to maintain mobility, strengthening of the quadriceps and hamstrings for joint stability, aerobic activities like walking, cycling, or aquatic exercises to improve endurance, proprioception and balance training to enhance joint control and prevent falls.[23]

Exercises, including sit to stand, stair climbing and step ups, further support daily activity. Regular engagement in these exercises has been shown to alleviate pain, improve physical function, and slow disease progression.[24] Electrotherapy serves as an adjunct to exercise in knee osteoarthritis management, helping to relieve pain and stimulate muscle.[25]

Modalities include Transcutaneous Electrical Nerve Stimulation [TENS], Ultrasound therapy, Short-wave diathermy, and cryotherapy or thermotherapy for pain modulation and tissue relaxation. Evidence suggests that these techniques provide short-term pain relief and support greater participation in exercise therapy.[26] Knee Osteoarthritis was treated using Transcutaneous Electrical Nerve stimulation to relieve osteoarthritic pain that facilitate therapeutic activity to maintain joint function.

Exergaming derived from “exercise” and “gaming”, refers to interactive, movement-based video gaming systems that combine physical activity with digital gaming environments. It represents a non-or semi-immersive form of virtual reality where users perform exercises while interacting with virtual objects or scenarios through body motion and sensors or wearable devices.[27]

Exergaming promotes neuromuscular re-education by providing task-orients, repetitive and feedback- driven movements, which enhance the recruitment of motor units and muscle coordination around the knee joint.[28] Virtual tasks engage muscles like quadriceps, hamstrings and gluteals dynamically enhancing joint stability and proprioception. Such tasks require multi-joint coordination and activation along the kinetic chain, which in turn improve lower limb function and general quality of life.[29]

Because virtual reality exercises are task-specific they support motor learning by facilitating the transfer of improvements from virtual to real-world physical activities.[30] Virtual reality and exergaming have been increasingly used as rehabilitation tools for patients with knee osteoarthritis to promote engagement, motivation and adherence to therapy programs.[31] Regular engagement with exergames maintains muscle strength, joint mobility, and balance improvements achieved during supervised therapy, leading to prolonged functional independence.[32]

MATERIALS & METHODS

This is a quasi-experimental study design approved by the Ethical Committee of GSL Medical College and General Hospital. The study was conducted for period of 1 year, from July 1st 2024 to June 30th 2025 at Department of physiotherapy OPD, Tertiary Care Teaching Hospital, Rajamahendravaram. 180 subjects were

screened, and according to inclusion and exclusion 150 subjects were randomly allocated through systematic random sampling into two groups, each group containing 75 subjects. Informed consent will be obtained from the participants and demographic data will be recorded. Group-A received Exergaming and Group-B received Standard Care Physiotherapy. Subjects received 3 sessions in a week for 6 weeks. Visual Analogue Scale, Universal Goniometer and WOMAC was used for Pain, Range of motion and function to evaluate both the groups before and after the intervention.

Inclusion criteria: Age above 35-65 years of both male and female. Subjects were diagnosed by Orthopaedician. Participants who were willing to participate in the study. Knee pain persisting for at least 3 months with pain severity during walking is more than or equal to 2/10 on Visual Analogue Scale. Kellgren-Lawrence grade 1 and 2 with unilateral involvement. Able to walk at least 30 feet without any physical assistance.

Exclusion criteria: Severe hearing loss and visual deficits. Previous orthopaedic surgeries within 6 months. Neurological diseases with central and peripheral involvement. Loss of foot sensitivity. Cognitive impairment. Vestibular and vision problems.

Outcome Measures:

VAS (VISUAL ANALOGUE SCALE):[33]

Measurement of pain severity. The VAS scale is a reliable, valid, responsive, and frequently used Pain outcome measure. The instrument used consists of horizontal lines, 10cm long with anchor points of 0 (no Pain) and 10 (severe Pain). It located at either end of the line. Patients are instructed to draw a vertical mark on the line indicating their Pain level.

Universal Goniometer (UG):[21]

The Universal Goniometer (UG) is a widely used, reliable, valid, and responsive tool for assessing range of motion. The full-circle or Universal Goniometer is a versatile instrument designed to measure peripheral joint ROM in individuals. As a 360-degree protractor, it allows motion to be measured in a single plane by aligning the device with the joint's axis. It primarily consists of three main components.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC):[21]

A patient reported scale was used to assess pain, physical function levels in the subjects. It measures 5 items of pain, 2 items for stiffness and 17 for functional limitation. Physical Functioning questions cover activities of daily living.

INTERVENTION

GROUP-A EXERGAMING:

In this Exergaming Group, subjects were allocated to virtual reality exercises. Exergaming games were played in virtual reality environment by using BOBO virtual tool. Virtual reality exercises include knee flexion and extension exercises, stationary bicycle exercise and stepping over obstacles with virtual reality game played in virtual environment. Each treatment session lasted for a total of 40 minutes, 3 times per week for 6 weeks, under the supervision of a Physiotherapist.[34]

KNEE FLEXION AND EXTENSION EXERCISE PROCEDURE:

Participants were seated on a stable chair with motion sensors attached near the shin of lower limb. Within the virtual game, participants were instructed to perform active knee flexion and extension movements to control an on-screen object. Each movement was performed slowly through the pain-free range. The virtual reality software provided real-time visual and auditory feedback on the amplitude and speed of motion. (fig. 1)

DURATION: 3 Sessions per week for a period of 6 weeks.

FIG. 1: KNEE FLEXION AND EXTENSION EXERCISE

STATIONARY BICYCLE EXERCISE
PROCEDURE:
The participant cycled on a stationary bicycle connected to a virtual reality screen. When the participant pedaled, the system gave real-time feedback on speed and displayed visual rewards to motivate them to continue cycling. The exercise was done at a low to moderate intensity. The resistance level on the cycle was adjusted according to each participant comfort without causing knee pain and discomfort. Resistance levels and duration were gradually increased depending on participant tolerance and knee comfort. Continues cyclic motion improves joint lubrication and enhances Quadriceps endurance. (fig. 2)
DURATION: 3 Sessions per week for a period of 6 weeks.

FIG. 2: STATIONARY BICYCLE EXERCISE

STEPPING OVER OBSTACLES
PROCEDURE:
Participants stood in front of virtual reality display wearing motion sensors on lower limb. The game simulated stepping over virtual obstacles appearing at different heights and positions. Participants were instructed to lift one leg at a time, maintaining balance and proper posture, while focusing on foot clearance. Real -time visual feedback assisted in maintaining correct alignment and adjusting movement. (fig. 3)

DURATION: 3 Sessions per week for a period of 6 weeks.

FIG. 3: STEPPING OVER OBSTACLES

GROUP-B: STANDARD CARE PHYSIOTHERAPY:

In this Standard Care Physiotherapy, subjects were received strengthening and stretching exercises for treating Knee Osteoarthritis.[22]

STRENGTHENING EXERCISES:

STATIC QUADRICEPS EXERCISE: The position of the patient in supine lying, therapist stands beside the patient. A rolled-up towel was put beneath the knee and they were instructed to maximally contract their thigh muscles to straighten their knee.

Duration: 10 repetitions for 10 seconds hold, 3 Sessions per week for a period of 6 weeks.

VASTUS MEDIALIS OBLIQUE EXERCISE:

The position of the patient in supine lying, therapist stands beside the patient. Then the patient legs are bent at the knee with feet flat on the floor, hip-width apart. Places a pillow or small cushion between knees and instructed them to squeeze it hard enough to produce a slight resistance.

Duration: 10 repetitions for 10 seconds hold, 3 Sessions per week for a period of 6 weeks.

RESISTED QUADRICEPS EXERCISE: The position of the patient in supine lying, therapist stands beside the patient. Secured a weight cuff around patient's ankle. Then slowly extends the leg, straightening the knee until leg is out in front of them.

Duration: 10 repetitions for 10 seconds hold, 3 Sessions per week for a period of 6 weeks.

HAMSTRINGS STRENGTHENING EXERCISE: The position of the patient in prone lying with a small towel roll under the femur joint proximal to the patella to avoid the compression of the patella between the treatment table and femur, therapist stands beside the patient. Attached a weight cuff to the ankles, then slowly bend the knees by bringing the heel towards the glutes. Throughout the motion, engaged their hamstrings and lift as far as they feel comfortable.

Duration: 10 repetitions for 10 seconds hold, 3 Sessions per week for a period of 6 weeks.

HIP ABDUCTORS STRENGTHENING EXERCISE: The position of the patient in side lying, therapist stands behind the patient. Attached a weight cuff to the ankles, then slowly lift the leg upward by keeping it straight. Throughout the motion, engaged their hip abductors and lift as far as they feel comfortable.

Duration: 10 repetitions for 10 seconds hold, 3 Sessions per week for a period of 6 weeks.

STRETCHING EXERCISES:

CALF STRETCHING: The position of the patient in supine lying, therapist stands beside the patient. With one hand therapist stabilizes the knee with the other hand holds the heel and rest of the foot supported on therapist forearm then gently stretch is applied.

Duration: 3 repetitions for 30 seconds hold, 3 Sessions per week for a period of 6 weeks.

HAMSTRINGS STRETCHING: The position of the patient in supine lying, therapist stands beside the patient leg to be stretched, lifting it while keeping the other leg flat on the table. The therapist supports the patient's leg by holding it just above the knee with one hand and the ankle with the other, then the leg is slowly raised until the patient feels a gentle stretch.

Duration: 3 repetitions for 30 seconds hold, 3 Sessions per week for a period of 6 weeks.

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION: [35]

Transcutaneous Electrical Nerve Stimulation (TENS) is a therapeutic treatment used to relieve knee pain and facilitate exercise participation in patients with osteoarthritis. Participants were positioned comfortably in long sitting with the knee slightly flexed. Two self-adhesive electrodes (5 × 5 cm) were placed bilaterally over the medial and lateral joint lines of the affected knee. Conventional (high-frequency) TENS parameters were applied with a frequency of 80–100 Hz, pulse width of 50–100 μs, and intensity adjusted to produce a strong but comfortable tingling sensation without muscle contraction. Each session lasted for 20 minutes, conducted three times per week for six weeks.

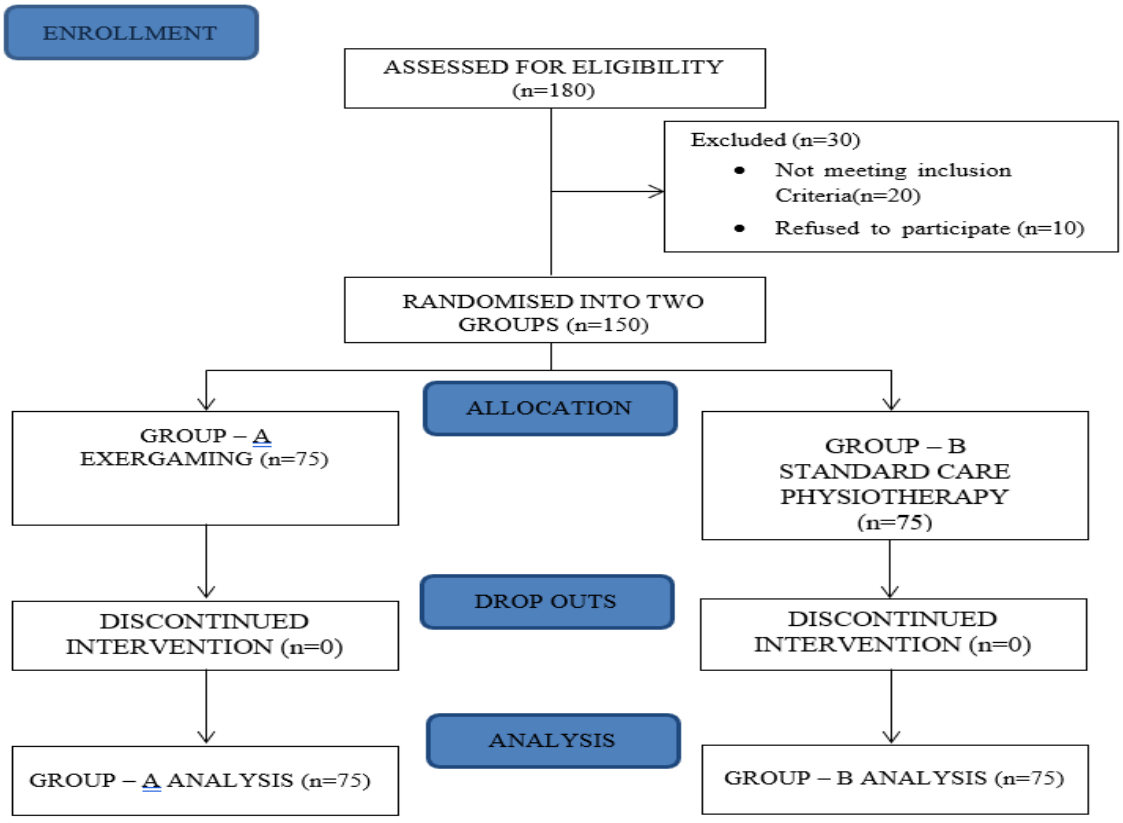

FIG. 4: CONSORT FLOW CHART OF STUDY PARTICIPANTS FROM ENROLLMENT TO ANALYSIS

Statistical Analysis

Statistical analysis was done using SPSS software version 20.0 and Microsoft excel 2019. All Descriptive data was presented in the form of mean ± standard deviation and mean difference percentages were calculated and presented. Within the groups paired student "t" test was performed to assess the statistical difference with in the group on Pain, Range of motion and function from pre- test and post- test values. Between the groups independent student "t" test was performed to assess the statistically significant difference mean value between the groups on Pain, Range of motion and Function. Data was tabulated and graphically represented. For all statistical analysis, $p<0.05$ was considered as statistically significant.

RESULT

The results of the study were analysed in terms of Pain, Range of motion and Function. The consort flowchart of the study showed the study organization in terms of subject's enrolment, screening, allocation, and analysis following intervention as shown in figure 4.

The study compared the effect Exergaming and Standard Care Physiotherapy on Pain, Range of motion and Function in subjects with knee osteoarthritis. A total of 180 subjects were screened for eligibility among them 150 subjects were recruited under the inclusion and the exclusion of the study. Each participant was randomly assigned to one of two groups, each consisting of 75 subjects, after completing baseline assessments. Treatment was conducted three times a week for six weeks. At the end of the intervention, all 150 participants, 75 in Group A and 75 in Group B completed the treatment. At a significance level set at $p \leq 0.05$, both the groups demonstrated statistically significant improvements in VAS, Universal Goniometer and WOMAC scores with group A being more effective than group B.

TABLE 1: ANALYSIS OF PRE TEST SCORES OF VISUAL ANALOGUE SCALES IN BETWEEN GROUP A AND GROUP B:

VISUAL ANALOGUE SCALE		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
PRE TEST	GROUP A	6.84	0.75	0.243	INSIGNIFICANT
	GROUP B	6.98	0.77		

The above table 1 indicate that the PRE-TEST mean scores of the visual analouge scale between the two groups were found to be statistically insignificant ($p<0.05$). Group A had a PRE -TEST mean score of 6.84, while Group B had a PRE-TEST mean score of 6.98 indicating an insignificant difference of PRE-TEST values between groups A and B.

TABLE 2: ANALYSIS OF POST TEST SCORES OF VISUAL ANALOGUE SCALES IN BETWEEN GROUP A AND GROUP B:

VISUAL ANALOGUE SCALE		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
POST TEST	GROUP A	2.84	0.75	0.001	HIGHLY SIGNIFICANT
	GROUP B	3.98	0.77		

The above table 2 indicate that the POST-TEST mean scores of the visual analouge scale between the two groups were found to be statistically highly significant ($p<0.05$). Group A had a POST-TEST mean score of 2.84, while Group B had a POST-TEST mean score of 3.98 indicating statistically significant difference of POST-TEST values between groups A and B.

TABLE 3: ANALYSIS OF PRE TEST SCORES OF WOMAC IN BETWEEN GROUP A AND GROUP B:

WOMAC		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
PRE TEST	GROUP A	45.18	2.70	0.0996	INSIGNIFICANT
	GROUP B	45.74	2.57		

The above table 3 indicate that the PRE-TEST mean scores of the WOMAC between the two groups were found to be statistically insignificant ($p<0.05$). Group A had a PRE -TEST mean score of 45.18, while Group B had a PRE-TEST mean score of 45.74 indicating an insignificant difference of PRE-TEST values between groups A and B.

TABLE 4: ANALYSIS OF POST TEST SCORES OF WOMAC IN GROUP A AND GROUP B:

WOMAC		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
POST TEST	GROUP A	19.18	2.70	0.0001	HIGHLY SIGNIFICANT
	GROUP B	29.74	2.56		

The above table 4 indicate that the POST-TEST mean scores of the WOMAC between the two groups were found to be statistically highly significant ($p<0.05$). Group A had a POST-TEST mean score of 19.18, while Group B had a POST-TEST mean score of 29.74 indicating statistically significant difference of POST-TEST values between groups A and B.

TABLE 5: ANALYSIS OF PRE TEST SCORES OF RANGES OF MOTION IN GROUP A AND GROUP B:

KNEE FLEXION		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
PRE TEST	GROUP A	104.92	3.64	0.467	INSIGNIFICANT
	GROUP B	104.48	3.75		

The above table 5 indicate that the PRE-TEST mean scores of the range of motion between the two groups were found to be statistically insignificant ($p<0.05$). Group A had a PRE -TEST mean score of 104.92, while Group B had a PRE-TEST mean score of 104.48 indicating an insignificant difference of PRE-TEST values between groups A and B.

TABLE 6: ANALYSIS OF POST TEST SCORES OF RANGES OF MOTION IN GROUP A AND GROUP B:

KNEE FLEXION		MEAN	STANDARD DEVIATION	P VALUE	INFERENCES
POST TEST	GROUP A	130.06	3.35	0.0001	HIGHLY SIGNIFICANT
	GROUP B	119.64	3.44		

The above table 6 indicate that the POST-TEST mean scores of the range of motion between the two groups were found to be statistically highly significant ($p<0.05$). Group A had a POST-TEST mean score of 130.06, while Group B had a POST-TEST mean score of 119.64 indicating statistically significant difference of POST-TEST values between groups A and B.

DISCUSSION

The aim of the study was to evaluate the effect of Exergaming and Standard Care Physiotherapy on pain, range of motion and function in subjects with Knee Osteoarthritis. In this study, subjects were assessed for knee osteoarthritis underwent Exergaming and Standard Care Physiotherapy which were performed for 6 weeks. In this study, subjects were assessed for pain, range of motion and function. The

following outcome measures are visual analogue scale, universal goniometer, and WOMAC were used to measure the intensity of pain and function.

Subjects were assessed for pain, range of motion and function at baseline and after six weeks of intervention using VAS for pain, WOMAC for function.There is significant difference showed after six weeks of interventions in all outcome measures in Exergaming and Standard Care Physiotherapy groups. There is statistically significance difference shown between Exergaming and Standard Care Physiotherapy group in improving pain, function and range of motion after 6 weeks of intervention in subjects with knee osteoarthritis.

In Group-A [Exergaming] there were statistically more significant improvements were observed at the end of the study at 6th week [p=0.001] for the VAS scores. Additionally, statistical significant improvements were also seen in WOMAC scores [p=0.001]. The exercises in this group which were shown to effectively strengthen key muscles such as Quadriceps and hamstrings, which enhance joint stability.

According to Yilmaz Demiriz et al concluded that in subjects with knee osteoarthritis, the results showed that a Virtual reality based approach performed better than a traditional therapy program.[36] Participants in Group A underwent a structured exergaming-based virtual reality program include interactive balance and mobility exercises delivered through visual and auditory feedback. The present study found that exergaming resulted in a significant reduction in pain, thereby decreased VAS scores after post-intervention.

This finding is consistent with the results of Manlapaz et al. (2022), who reported that exergaming using Nintendo Wii Fit™ significantly improved pain and balance in individuals with knee OA.[37]The immersive nature of virtual environments helps patients focus less on their pain and stay more engaged in the activity. Group A exhibited a statistically significant improvement in knee flexion. These results explained by the task-oriented and repetitive movements involved in exergaming, which stimulate joint mobility and muscle activation.

Byra J, Czernicki K. (2020) reported that Virtual reality-based proprioceptive exercises enhance joint movement through feedback-driven motor learning and dynamic muscle control.[38] The active visual feedback during Virtual reality exercises encourages proper joint movement, thereby preventing stiffness and promoting synovial fluid circulation, which contributes to pain relief and increased flexibility.With regard to functional outcomes, as assessed by the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Participants in Group A showed significant improvements in daily activities such as walking, stair climbing, and sitting to standing. The outcomes observed in Group A can be attributed to a combination of enhanced neuromuscular activation, sensorimotor integration, and psychological engagement, all of which contribute to improved pain modulation, joint mobility, and functional recovery. Similar observations were reported by Oliveria et al. (2024), who demonstrated that virtual reality training improved anticiptory postural adjustments and pain outcomes more effectively than traditional kinesiotherapy in knee osteoarthritis patients.[39]

In Group-B [Standard Care Physiotherapy] of current study had significant improvement on VAS [p=0.001] , universal goniometer [p=0.001] and WOMAC [P=0.001]. In Group-B participants were given strengthening exercises, stretching exercises and TENS Transcutaneous Electrical Nerve Stimulation]. The findings revealed a significant reduction in VAS scores, indicating effective pain relief following the 6-week program. This supports with the results of Bakki and Ahmed (2023) and Ojoawo et al. (2016),

who reported that structured exercise programs and electrotherapy interventions effectively alleviate pain and improve knee joint function in osteoarthritis.[40] In terms of range of motion, Group B participants showed moderate improvement following the intervention. Repetitive stretching and strengthening exercises, promote synovial fluid movement and joint lubrication, which helped in restoring flexibility.

Yu Wu, Feilong Zhu, Wei Chen et al (2021) the study showed that TENS provide significant immediate pain relief, along with sustained medium- and long-term analgesic benefits. Study findings indicate that TENS can serve as an effective adjunct therapy to reduce knee dysfunction and enhance walking ability, supporting its use in evidence-based management of knee osteoarthritis.[35] The functional improvement, reflected by better WOMAC scores in Group B, suggested that conventional physiotherapy shown an effective component of conservative management for knee Osteoarthritis. Quadriceps strengthening, in particular, enhances joint stability and reduces compressive forces on the knee.

Chinelo N onwunzo et al stated that the exercise group increased quadriceps strength and decreased discomfort may be the cause of their enhanced function and decreased pain, which in turn increases the stability of their knee joint.[41] The findings of this study indicate that exergaming shown significant effect adjunct to conventional physiotherapy in the management of knee osteoarthritis. Although standard physiotherapy continues to be a reliable and evidence-based approach for alleviating pain and improving joint function, the integration of virtual reality–based exergaming offers a more interactive, and motivating rehabilitation strategy.

After six weeks of intervention the results showed significant improvement in all outcome measures i.e visual analouge scale, universal goniometer and WOMAC in Exergaming compared to standard care physiotherapy. Therefore the study concludes that Exergaming was effective intervention for reducing pain and improving range of motion and function.

CONCLUSION

The present study concluded that 6 weeks intervention of Exergaming and Standard care Physiotherapy were shown statistically significant difference in reducing Pain, improving range of motion and Function. However, more percentage of improvement was found in subjects received Exergaming when compared to Standard Care Physiotherapy. From the findings of the current study, it can be recommended that Exergaming maybe opted as a treatment of choice for reducing Pain, improving range of motion and Function in subjects with Knee Osteoarthritis.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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