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Effectiveness of Supervised and Unsupervised Exercise Protocol on Pain, Range of Motion, and Physical Function in Knee Osteoarthritis Patients

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ABSTRACT

Introduction: Osteoarthritis (OA) is a prevalent joint disorder worldwide, particularly among the elderly, and poses a significant health challenge in many societies. Also referred to as degenerative arthritis, it primarily impacts the hands, feet, spine, and large weight- bearing joints like the hips and knees. Physical therapy, particularly rehabilitation exercises aimed at strengthening the muscles around the knee, enhancing range of motion, and alleviating pain, plays a vital role in the non-surgical treatment of OA. These exercises often require patients to attend specialized clinics for multiple sessions to achieve optimal results. Tele-rehabilitation (tele-rehab), which uses information and communication technology to deliver services remotely, offers the potential for reduced transportation costs, saving time and treatment expenses. Comparing the effectiveness of these two treatment methods can help shape better management strategies for knee OA patients, leading to improved outcomes and more efficient healthcare delivery.

MATERIALS AND METHODS: This study is a randomised controlled trial (RCT), in which we compared the effect of exercises protocol on pain, range of motion and physical function on knee osteoarthritis via supervised (in person) and unsupervised (tele rehab) mode of treatment

RESULTS: Comparing the two groups, the results revealed no significant difference between the supervised and unsupervised groups in terms of the overall improvement across the measured outcomes. Both the supervised and unsupervised groups demonstrated significant improvements in pain, physical function, and knee joint range of motion following the intervention. However, the supervised group exhibited more pronounced outcomes across all variables. Specifically, the supervised group showed significantly greater reductions in pain, both at rest (NPRS REST) and during activity (NPRS ACTIVITY), as well as more substantial improvements in physical function (WOMAC index) and range of motion, with all results yielding p-values < 0.0001. Although the unsupervised group also experienced notable improvements, the supervised group showed superior gains, indicating the added benefit of in-person supervision in the rehabilitation process.

CONCLUSION: In summary, while both supervised and unsupervised exercise protocols are beneficial for managing knee OA, supervised in-person therapy offers superior outcomes in reducing pain, improving ROM, and enhancing physical function. The personalized guidance, immediate feedback, enhanced motivation, and structured environment provided in supervised settings contribute to these superior results. Healthcare providers must take these factors into account when designing treatment plans for knee OA patients, aiming to incorporate supervised exercise interventions to maximize therapeutic benefit.

Keywords; *Knee osteoarthritis, supervised, traditional in person, unsupervised, tele- rehabilitation*

Abbreviation: osteoarthritis: OA, Western Ontario and McMaster Universities Arthritis Index: WOMAC, Numerical pain rating scale: NPRS

1. INTROUCTION

Osteoarthritis (OA) is a common joint condition worldwide, especially among the geriatric population, and it is a major health concern in several societies [1]. It is also referred to as degenerative arthritis and typically impacts the hands, feet, spine, and major weight-bearing joints like the hips and knees [2, 3]. The majority of OA cases have no identified cause and are classified as primary OA [4]. Primary osteoarthritis is primarily associated with the aging process. [2, 3]. It can occur as localized, generalized, or erosive OA[4,5]. Secondary osteoarthritis is the result of another disease or condition [5]. The overall prevalence of knee OA was found to be 28.7%. OA is closely linked to aging and intense physical labor, which is often a necessity for many individuals in rural communities of developing countries [6].

Osteoarthritis (OA) is the second most prevalent rheumatologic disorder and the leading joint disease, with a prevalence ranging from 22% to 39% in India [2, 4]. Among the various joints in the body, the knee joint is the most commonly affected by OA [7]. Treatment strategies for managing OA typically include pharmacological options, non-pharmacological approaches, and surgical interventions. In recent years, a significant number of studies have been published evaluating non-pharmacological treatments, particularly physical therapy interventions, for OA patients [8]. These studies have provided substantial evidence that well-structured exercises can effectively reduce pain and enhance functional ability in individuals with OA [9, 10].Physical therapy plays a crucial role in the non-surgical management of OA. Specifically, rehabilitation exercises aimed at strengthening the muscles surrounding the knee, improving joint range of motion, and alleviating pain are considered fundamental components of OA management [11]. However, to achieve the best results, patients with OA typically need to attend multiple sessions at specialized physical therapy clinics. This requirement can present a challenge, especially for middle-aged and elderly patients who may find it difficult to visit clinics regularly over extended periods, particularly those living in remote or rural areas. For these patients, attending frequent physical therapy sessions is not only time-consuming but also incurs significant financial costs and necessitates reliable transportation, further exacerbating the difficulties of consistent care. Therefore, while physical therapy offers substantial benefits for OA management, the practical challenges associated with regular clinic visits, especially for patients in remote locations, highlight the need for more accessible alternatives that reduce time, cost, and transportation burdens [12, 13].

Unsupervised (tele-rehablitaion) utilizes information and communication technology to provide services to individuals outside traditional rehab clinics, offering the potential for reduced transportation needs and, as a result, lower treatment costs and time savings. Several studies have explored the effectiveness of tele-rehab for OA management, and numerous clinical trials are currently in progress to further evaluate its impact [14, 15]. To address these barriers, telehealth rehabilitation has emerged as an alternative form of therapy. Telehealth rehabilitation involves the delivery of remote therapeutic interventions via digital platforms, such as video consultations, mobile applications, or virtual exercise programs, which allow patients to receive care from the comfort of their homes [16]. The advent of telehealth has raised important questions regarding its effectiveness in comparison to traditional in-person

therapy. While the convenience and accessibility of telehealth are widely touted, it is essential to critically assess whether remote rehabilitation can achieve the same clinical outcomes as face-to-face therapy. Key factors to consider include improvements in pain management, functional mobility, strength, patient satisfaction, and overall health outcomes. Additionally, the role of technology, the level of patient engagement critical elements in determining the success of telehealth interventions.

Understanding the comparative effectiveness of these two treatment options can help guide the development of comprehensive management strategies for knee OA patients, ultimately enhancing patient outcomes and optimizing healthcare delivery. For patients with knee OA, telehealth rehabilitation could reduce the need for frequent visits to clinics, making it a more convenient option for individuals who have difficulty traveling, live in rural areas, or face mobility limitations. Telehealth can provide greater access to rehabilitation services, telehealth could potentially lower healthcare costs by reducing the need for travel, in-person appointments, and clinic-based facilities.

A study assessing the effectiveness of unsupervised (telehealth rehabilitation) for knee OA compared to supervised (traditional in-person therapy is essential to understand its true potential, challenges, and impact on clinical outcomes. Such a study could provide critical evidence to guide future rehabilitation practices and policies, helping to optimize care delivery for this large and growing patient population.

2. MATERIALS AND METHODOLOGY

This study was a randomized controlled trial (RCT) that compared the effects of an exercise protocol on pain, range of motion, and physical function in knee osteoarthritis, using both supervised (in-person) and unsupervised (tele-rehab) treatment modes. The study design and protocol were Evaluated and authorized by the protocol and ethical committee.

Patient selection

Individuals above 45 years, and diagnosed with knee osteoarthritis and according to inclusion and exclusion criteria.

Inclusion criteria:

1. Age group: above 45 years.
2. Gender: Male and Female.
3. Diagnosed with knee osteoarthritis (Grade 1 and 2) on x-ray.

Exclusion criteria:

1. Grade 3 and 4 knee osteoarthritis.
2. Sever osteoporosis.
3. Osteomyelitis of any lower limb joint.
4. Individuals with recent fractures of lower limbs.
5. Recent surgeries around lower limb joints.
6. Individuals unwilling to participate in the study.

Sampling and randomization

The sample size was estimated using the formula for comparing two proportions, which was determined to be 160 with an allowable error of 0.07%. Once written informed consent was obtained, eligible patients were randomly allocated to two groups. One group received the exercise protocol through supervised (in-person) treatment, while the other group underwent the unsupervised (tele-rehab) mode of treatment.

Pre- and post-treatment evaluations

Prior to the first Therapy Ahead of the first session, consent was secured from participants in both groups, demographic details were collected, and the severity of Knee pain was gauged with the help of the Numerical Pain Rating Scale (NPRS). The Western Ontario and Macmaster Universities Osteoarthritis Index (WOMAC) was then administered In order to assess the patients' physical function [17]. After a 4-week treatment period, pain levels were reassessed using the NPRS, and physical function was re-evaluated using the WOMAC index.

Intervention

Both groups received the same exercise protocol, but through different methods. The unsupervised (tele-rehab) group received treatment via telecommunication platforms. Additionally, they were supplied with a pamphlet that included descriptions and pictures of the exercises, and they were instructed to maintain a logbook to record their activities. Patients were requested to perform the exercises Three times per week over a period of (a total of 12 sessions), and were advised to apply a hot pack to their knees for 10 minutes before each session. This allowed us to remotely track their progress, ensure they adhered to the exercise routine, and monitor improvements in their symptoms. Patients were instructed to follow the exercise program as detailed in the pamphlet.

In the supervised (in-person therapy) group, patients visited the clinic Three times per week over a period of 4 weeks (a total of 12 sessions) and were provided with the same exercise protocol as the tele-rehab group. They were also instructed to continue the exercises at home between sessions.

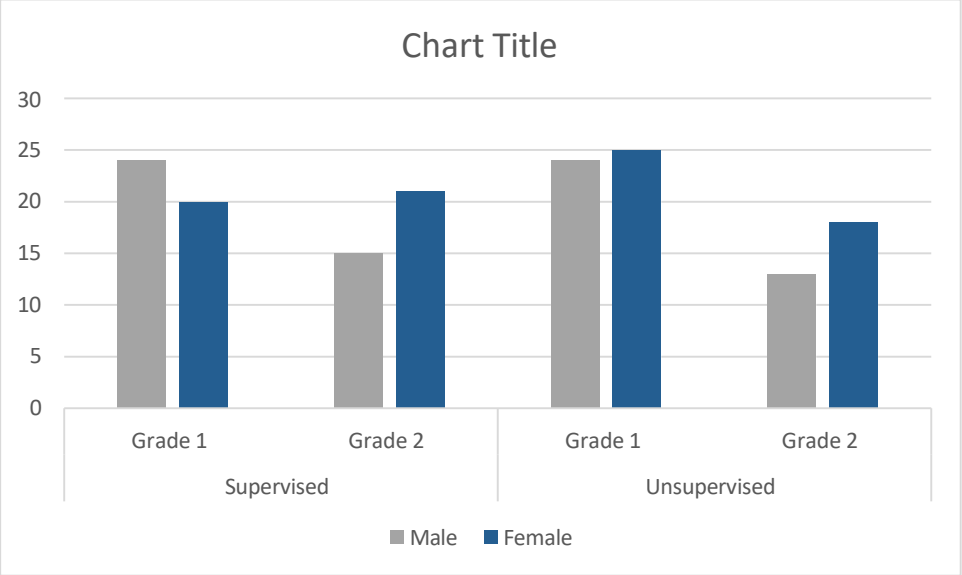
Intervention duration: 4 weeks, 3 time a week.

3. RESULTS

Table 1: gender

Gender	Supervised		Unsupervised	
	Grade 1	Grade 2	Grade 1	Grade 2
Male	24	15	24	13

Female	20	21	25	18

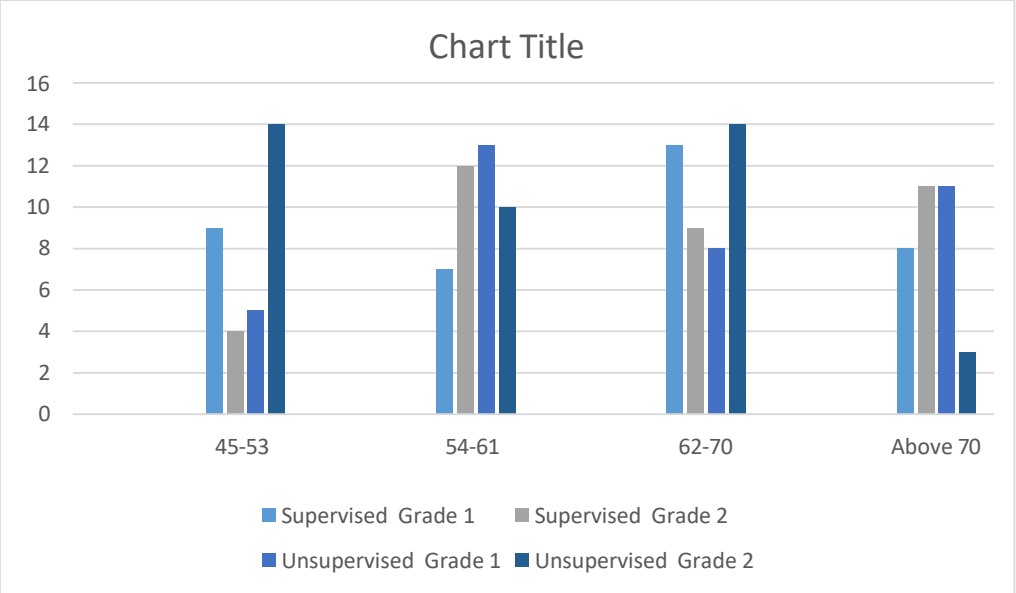


Interpretation

A total of 175 individuals were initially assessed to determine their suitability for participation in the study. From this group, 160 participants were found to meet the necessary inclusion criteria. Among these 160 eligible individuals, there was a slight gender difference within the supervised group, with 48.75% being men and 51.25% being women. In contrast, within the unsupervised group, the gender distribution was somewhat reversed, with 53.7% being women and 46.25% being men. Additionally, the table provided also outlines the distribution of men and women based on their respective grade levels, offering a more detailed breakdown of the participants by gender within each category.

Table 2: Age

Age	Supervised		Unsupervised	
	Grade 1	Grade 2	Grade 1	Grade 2
45-53	9	4	5	14
54-61	7	12	13	10
62-70	13	9	8	14
Above 70	8	11	11	3



Interpretation

The table presents a detailed distribution of participants by age and grade within both the supervised and unsupervised groups. In the supervised group, individuals aged 45-53 years are predominantly placed in Grade 1 (9 participants), with fewer in Grade 2 (4 participants). Among those aged 54-61 years, a greater number are assigned to Grade 2 (12 participants) compared to Grade 1 (7 participants). For the 62-70 age group, 13 participants are in Grade 1, while 9 are in Grade 2. In the over-70 category, a larger proportion of participants are placed in Grade 2 (11 participants) than in Grade 1 (8 participants), suggesting that older individuals in the supervised group tend to be assigned to more advanced grades. In the unsupervised group, the distribution is somewhat different. For the 45-53 age range, a greater number of participants are assigned to Grade 2 (14 participants) than to Grade 1 (5 participants). The 54- 61 age group exhibits a more balanced distribution, with 13 participants in Grade 1 and 10 in Grade 2. Among those aged 62-70, 14 individuals are in Grade 2, compared to 8 in Grade 1. In the over-70 category, a significant majority of participants are placed in Grade 1 (11 participants), with only 3 in Grade 2. This suggests that older participants in the unsupervised group are more likely to be placed in the earlier grade. Overall, the data indicates that, while there is a tendency for older participants to be assigned to Grade 2 in the supervised group, the unsupervised group demonstrates a more varied distribution, particularly among the oldest participants.

Table 3: Supervised group

	PRE	POST	P VALUE
NPRS REST	4.06±0.84	2.47±1.13	<0.0001
NPRS ACTIVITY	7.28±1.80	5.05±0.79	<0.0001
WOMAC	83.96±3.32	80.385±3.50	<0.0001
Range of motion (knee joint)	120.03±0.83	122.53±0.57	0.0001

Interpretation

The statistical analysis of the supervised group was displayed in the table above. According to the Wilcoxon matched pairs signed test, the p-value of the NPRS scores at rest and during activity is highly significant i.e. p-value <0.0001. The WOMAC index's p-value, which is likewise highly significant, is displayed in this table along with the p-value of range of motion of knee joint is also considerably significant .Therefore, the effect of the exercise protocol on pain and physical function in the supervised group is extremely significant.

Table 4: Unsupervised group

	PRE	POST	P VALUE
NPRS REST	4.17±0.79	3.81±0.79	0.0010
NPRS ACTIVITY	7.61±1.80	6.67±0.95	0.003
WOMAC	83.07±0.85	83.538±1.63	0.0423
Range of motion (knee joint)	120±0.503	121±2.34	0.0497

Interpretation

The table above showed the results of the unsupervised group statistical analysis. The p-value of the NPRS scores during activity and at rest is significantly significant, according the Wilcoxon matched pairs signed test. This table shows the p-value of the WOMAC index, which

is also significant, as well as the p-value of the knee joint's range of motion. Consequently, there is a notable impact of the exercise regimen on pain and physical function in the group under supervision.

Table 5: Supervised group vs. unsupervised group

	Supervised	Unsupervised	
	POST	POST	P VALUE
NPRS REST	2.47±1.13	3.81±0.79	<0.0001
NPRS ACTIVITY	5.05±0.79	6.67±0.95	<0.0001
WOMAC	80.385±3.50	83.5±1.63	<0.0001
Range of motion (knee joint)	122.53±0.57	121±2.34	<0.0001

Interpretation

The results from the table show that both the supervised (in-person) and unsupervised (tele- rehab) groups experienced significant improvements in pain, physical function, and range of motion after treatment, but the supervised group had slightly better outcomes. For pain at rest (NPRS REST), the supervised group had a mean score of 2.47 ± 1.13, which showed a marked reduction compared to the than the unsupervised group's score of 3.81 ± 0.79 ($p < 0.0001$). Similarly, for pain during activity (NPRS ACTIVITY), the supervised group (5.05 ± 0.79) reported a considerable reduction in pain compared to the unsupervised group (6.67 ± 0.95) with a p-value of < 0.0001. In terms of physical function, the supervised group also showed a greater improvement on the WOMAC index (80.385 ± 3.50) compared to the unsupervised group (83.5 ± 1.63), with a p-value of < 0.0001, indicating better functional outcomes. Finally, while the range of motion (knee joint) was slightly better in the supervised group (122.53 ± 0.57) compared to the unsupervised group (121 ± 2.34), the p-value of < 0.0001 Indicates that this difference was statistically significant. Overall, while both treatment methods were effective, the supervised the group demonstrated more significant improvements.

4. DISCUSSION

In this study, we analysed the effectiveness of supervised versus unsupervised exercise protocols in managing knee osteoarthritis (OA) symptoms. Specifically, it compares the impact of these two mode of treatment on pain reduction, range of motion, and physical function in OA patients. The findings suggest that both supervised and unsupervised mode lead to improvements in these outcomes. However, the supervised exercise protocol was more effective, showing significantly greater reductions in pain at rest and during activity, better functional improvements (as measured by the WOMAC score), and slight improvements in knee joint range of motion compared to the unsupervised group. In this study, Range of motion in comparison with the supervised (in-person) and unsupervised (tele-rehab) treatment modalities on patients with knee osteoarthritis, with outcomes assessed before and after the treatment period. The data revealed significant improvements across both groups, with the supervised group showing more pronounced benefits in all measured variables.

Regarding pain reduction, both groups demonstrated improvements in pain levels at rest and during activity. In the supervised group, the Numerical Pain Rating Scale (NPRS) for rest dropped from 4.06 ± 0.84 to 2.47 ± 1.13, while the NPRS for activity decreased from 7.28 ±

1.80 to 5.05 ± 0.79, with both changes reached statistical significance ($p < 0.0001$). Similarly, the unsupervised group showed a reduction in pain, with NPRS REST improving from 4.17 ±

0.79 to 3.81 ± 0.79, and NPRS ACTIVITY improving from 7.61 ± 1.80 to 6.67 ± 0.95 ($p = 0.0010$ and $p = 0.003$, respectively). However, the supervised group had a significantly better reduction in pain, especially during activity, compared to the unsupervised group, indicating that in-person sessions may be more effective in managing pain.

Physical function, as measured by the WOMAC index, also showed improvement in both groups. In the supervised group, WOMAC scores improved from 83.96 ± 3.32 pre-treatment to 80.385 ± 3.50 post-treatment, which was statistically significant ($p < 0.0001$). The unsupervised group also experienced a slight improvement from 83.07 ± 0.85 to 83.538 ± 1.63 ($p = 0.0423$). Although the unsupervised group improved, the supervised group showed greater functional benefits. This suggests that direct supervision during physical therapy may lead to better adherence to exercise protocols and more effective functional improvements.

Range of motion (knee joint) increased in both groups, with the supervised group showing a greater improvement from 120.03 ± 0.83 to 122.53 ± 0.57 ($p = 0.0001$), compared to the unsupervised group, which improved from 120 ± 0.503 to 121 ± 2.34 ($p = 0.0497$). This further supports the idea that the supervised approach is more effective in improving joint mobility, potentially due to more direct monitoring and corrections during exercise sessions. When examining gender differences, the data shows a fairly balanced distribution between males and females in both the supervised and unsupervised groups. Nevertheless, there were a few more females in the unsupervised group (25 females in Grade 1, 18 in Grade 2) compared to males (24 males in Grade 1, 13 in Grade 2). The improvements in both pain reduction and physical function were similar across both genders, though there was a slight trend towards more significant improvement in males in the supervised group.

Age-wise, participants were divided into four age categories, and the distribution was relatively even between the supervised and unsupervised groups across different age ranges. The greatest improvements in physical function and pain reduction were observed in the younger groups (45-53 and 54-61 years), while older groups (62-70 and above 70 years) showed less dramatic

changes, suggesting that age may be a factor influencing treatment outcomes. Nonetheless, both treatment approaches were effective in all age groups, demonstrating a notable trend that Elderly patients might require further support or modifications to maximize benefits

However, when comparing the two groups, the results revealed no significant difference between the supervised and unsupervised groups in terms of the overall improvement across the measured outcomes. Despite this, there was an extremely

significant improvement in the supervised group when compared to the unsupervised group. The supervised group experienced more pronounced and sustained reductions in pain intensity and improvements in both physical function and range of motion. This is probably attributed to the direct supervision provided by trained professionals, which ensured proper exercise technique, personalized adjustments to the exercise protocol, and real-time feedback, which might have influenced to more effective and efficient rehabilitation. On the other hand, in the unsupervised group given through video call on electronic devices, although improvements were still evident, the absence of professional guidance and monitoring may have resulted in less optimal engagement, adherence, or exercise technique, leading to more modest improvements compared to the supervised group. These findings underline the importance of supervision in rehabilitation, where direct professional involvement not only ensures correct exercise execution but also enhances motivation, adherence, and overall treatment outcomes in knee OA management.

The study conducted by Kamran Azma et al. (2017) compared the effectiveness of tele- rehabilitation and office-based physical Therapeutic interventions for knee osteoarthritis patients (OA). The Focused on assessing the influence of two common rehabilitation approaches on pain and functional disability. Both tele-rehabilitation and office-based physical therapy were found to provide positive outcomes in reducing knee pain and improving physical function. However, the results revealed that office-based, supervised physical therapy led to more substantial improvements. Specifically, patients who participated in the office-based program showed statistically significant reductions in pain levels and greater improvements in disability scores compared to those who engaged in tele-rehabilitation or home-based exercise regimens [18].

A non-inferiority trial by Hinman et al. (2023) explored the comparison between video-based consultations and traditional face-to-face physiotherapy for knee OA patients. While the results indicated that video consultations were effective and provided similar benefits in managing knee OA, They were not an exact match for the outcomes observed in traditional, in-person physiotherapy. This highlights the key advantage of supervised, in-person rehabilitation, which allows for immediate feedback, hands-on adjustments, and real-time monitoring, elements that are challenging to replicate in a remote setting [19].

The systematic review and meta-analysis by Gabanela Schiavon MA et al. (2023) provides compelling evidence that supervised exercise interventions can significantly reduce knee pain and improve physical function in individuals with knee osteoarthritis (OA). While these unsupervised or telehealth-based interventions show promise, the results are not as robust when compared to clinic-based, supervised rehabilitation programs. The key difference lies in the personalized care and professional guidance that clinic-based treatments provide, which is crucial for optimizing rehabilitation outcomes. In supervised, in-person rehabilitation programs, participants benefit from direct interaction with trained healthcare professionals,

who can tailor exercises to the individual's specific needs, ensure correct technique, and monitor progress closely. The reason was this supervised exercise protocol for being more effective was because of a proper an efficient progressive guidance which was provided in a structured environment with utmost motivation at each step of the exercise regime. This gave the patient enough boost of motivation to perform and execute the exercises in a well manner with no hindrance [20].

The mechanisms behind the superior efficacy of supervised, in-person therapy are multifaceted. First, face-to-face consultations provide a personalized approach to treatment, where a physiotherapist can directly assess the patient's movement patterns, offer tailored exercise modifications, and ensure exercises are being performed correctly. These immediate corrections are critical in preventing improper movements that may exacerbate symptoms or lead to injury. Additionally, the hands-on nature of in-person therapy allows physiotherapists to address specific areas of weakness or imbalance, which is often less feasible through remote consultations.

Another factor that contributes to the success of supervised rehabilitation is the high level of patient adherence and motivation during in-person sessions. In a clinic-based setting, patients benefit from consistent encouragement and support, which fosters a sense of accountability and engagement in the treatment process. This level of motivation is often more challenging to achieve with unsupervised exercises or video-based consultations, where patients may not feel as committed to the prescribed exercises and may lack the discipline required to achieve optimal results.

5. CONCLUSION

In summary, while both supervised and unsupervised exercise protocols are beneficial for managing knee OA, supervised in-person therapy offers superior outcomes in reducing pain, improving ROM, and enhancing physical function. The personalized guidance, immediate feedback, enhanced motivation, and structured environment provided in supervised settings contribute to these superior results. Healthcare providers must take these factors into account when designing treatment plans for knee OA patients, aiming to incorporate supervised exercise interventions to maximize therapeutic benefits

6. LIMITATIONS

This study has several limitations that should be considered when interpreting its findings. First, the sample size and demographic distribution, particularly the slight gender imbalance in the unsupervised group, may introduce biases that could affect the generalizability of the results. Although both treatment groups showed improvements, the fact that the study did not include a long-term follow-up means it cannot assess whether the improvements in pain reduction, physical function, and range of motion are sustained over time. Additionally, while both groups demonstrated improvements, the study did not control for external factors that

could influence the outcomes, such as the motivation levels of participants or external support, which could have affected engagement and adherence.

Additional Information Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Sanika Milind Kulkarni, Trupti Yadav.

Acquisition, analysis, or interpretation of data: Sanika Milind Kulkarni, Trupti Yadav Drafting of the manuscript: Sanika Milind Kulkarni, Trupti Yadav

Critical review of the manuscript for important intellectual content: : Sanika Milind Kulkarni, Trupti Yadav

Disclosures Human subjects:

Consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, Krishna Vishwa Vidyapeeth, Karad issued approval 301/2024-2025. Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue. Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: Payment/services info: All authors have declared that no financial support was received from any organization for the submitted work. Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. Other relationships: All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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