The Role of Telerehabilitation-Based Exercises in the Management of Knee Osteoarthritis: A Narrative Review[*]

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Abstract

Knee osteoarthritis (KOA) is a progressive disease characterized by joint cartilage degeneration, with prevalence increasing with age. This condition causes pain and reduces quality of life. Traditional face-to-face rehabilitation may be limited by geographical and financial barriers. Telerehabilitation (TR) has emerged as a modern therapy method using digital platforms for remote exercise monitoring. This narrative review was conducted by searching PubMed and Google Scholar databases for studies published between 2010 and 2026 using keywords such as "knee osteoarthritis" and "telerehabilitation". Studies have shown that TR exercises may lead to reduced pain and improved joint function and quality of life. In conclusion, TR offers an effective treatment alternative, especially for those facing barriers to in-person care.

Keywords: Knee osteoarthritis, telerehabilitation, exercise therapy, remote rehabilitation, physical therapy modalities.

Diz Osteoartriti Yönetiminde Telerehabilitasyon Yoluyla Uygulanan Egzersizlerin Rolü: Bir Anlatı İncelemesi

Öz

Diz osteoartriti (KOA), eklem kıkırdağının dejenerasyonu ile karakterize ilerleyici bir hastalıktır. Bu durum, ağrıya neden olur ve yaşam kalitesini düşürür. Geleneksel yüz yüze rehabilitasyon, coğrafi ve finansal engeller nedeniyle kısıtlanabilir. Telerehabilitasyon (TR), dijital platformlar aracılığıyla uzaktan egzersiz takibi sağlayan modern bir yöntemdir. Bu anlatı incelemesi, 2010-2026 yılları arasında PubMed ve Google Scholar veri tabanlarında “diz osteoartriti” ve “telerehabilitasyon” anahtar kelimeleri kullanılarak yapılan taramalarla hazırlanmıştır. Araştırmalar, TR'nin ağrıyı azaltmaya ve fonksiyonları ve yaşam kalitesini iyileştirmeye yol açabileceğini göstermiştir. Sonuç olarak TR, yüz yüze tedaviye erişimde zorluk yaşayan bireyler için umut vadeden bir alternatiftir.

Anahtar Sözcükler: Diz osteoartriti, telerehabilitasyon, egzersiz tedavisi, uzaktan rehabilitasyon, fiziksel terapi modaliteleri.

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Introduction

Osteoarthritis (OA) is a chronic and progressive disease resulting in joint degeneration[1-2]. Knee osteoarthritis (KOA) is the most common form, affecting an estimated 240 million people globally[2]. KOA is a significant health issue associated with pain, physical disability, and early mortality in developed countries, leading to substantial increases in economic costs[3].

Telerehabilitation (TR) provides remote access to rehabilitation via telecommunication technology. TR provides synchronous or asynchronous access to the rehabilitation environment for healthcare professionals and patients through telephone, videoconferencing, and video recordings[4]. Exercise is one of the fundamental components of OA treatment. Especially in cases of KOA, exercises aimed at strengthening muscles, improving joint mobility, and increasing functional capacity can reduce pain, enhance joint function, and improve quality of life. However, ensuring that patients exercise regularly can be challenging due to physical limitations, geographical distances, or time constraints. At this point, TR can help individuals overcome these challenges by enabling them to follow their exercise programs in a guided manner. TR is considered to have the potential to be a long-term, sustainable treatment method for individuals with OA[5].

The aim of this study, conducted as a narrative review, is to investigate the effects of exercises delivered through TR on pain, functional capacity, mobility, and quality of life in individuals diagnosed with KOA and to compare their effectiveness with that of traditional face-to-face physiotherapy.

Material and Methods

This study was designed as a narrative review to evaluate the clinical effectiveness of TR in the management of KOA.

Search Strategy

A comprehensive literature search was performed in electronic databases, including PubMed and Google Scholar. The search criteria focused on peer-reviewed articles published in English and Turkish. Keywords used were “knee osteoarthritis,” “telerehabilitation,” and “exercise therapy.” Studies published between 2010 and 2026 that compared TR with face-to-face interventions or evaluated cost-effectiveness were prioritized.

Study Selection Process

Articles were selected based on the following criteria: (1) peer-reviewed original research or systematic reviews; (2) a focus on adult participants (typically aged 40–80 years) diagnosed with KOA; and (3) interventions comparing TR—delivered synchronously or asynchronously via phone, video, or sensor-based systems—with traditional face-to-face

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physiotherapy. Priority was given to randomized controlled trials (RCTs) and systematic reviews that reported outcomes for pain, functional capacity, mobility, and quality of life.

Synthesis Approach

Gathered data were analyzed using a qualitative synthesis approach, categorizing the evidence based on clinical efficacy (comparable effectiveness to usual care), operational protocols (frequency and duration), and cost-effectiveness.

Osteoarthritis

According to the definition of the Osteoarthritis Research Society International (OARSI), OA is a chronic degenerative inflammatory disease that begins with abnormal joint tissue metabolism and progresses to anatomical and/or physiological irregularities in the joint. Recent evidence suggests that OA involves not only the mechanical degeneration of articular cartilage but also structural and functional changes in several joint components, including subchondral bone, meniscus, synovium, and periarticular ligaments[2].

Patients with OA primarily complain of pain and stiffness in the affected joint or joints[6]. Pain is the most prominent symptom in OA, and 20% of chronic pain cases in Europe are associated with OA[7,8]. While pain in the early stages of the disease is activity-related, in the chronic stage its causes and timing become unpredictable[6]. It has been shown that long-term chronic pain in OA has negative effects on psychological health, sleep, and social participation[9,10]. Stiffness becomes more noticeable in the morning and after prolonged periods of rest during the day but typically resolves within 30 minutes[6]. Increased mechanical load due to cartilage–subchondral bone loss and degeneration of supporting structures may lead to bone misalignment or growth abnormalities[11,12]. Varus–valgus malalignments of the knee are frequently observed in OA[13].

Epidemiology and Global Impact

OA leads to functional loss and a reduction in activities[14]. In a study involving 10,000 patients, 81.5% of individuals with OA reported limitations in daily living activities; 61.1% experienced restricted mobility outside the home, and 12.8% had limited movement even within the home[15]. Decreased range of motion, crepitus, effusion, and, in advanced stages, muscle atrophy may also be observed[12,16]. All of these symptoms, along with chronic pain, reduce the patient's social participation and quality of life[6].

OA leads to significant workforce losses and high medical care costs. In the United States, OA-related cost losses amount to $65 billion, while direct medical costs exceed $100 billion. Additionally, it is known that an individual incurs a total of $15,000 in medical expenses over their lifetime due to OA[17].

Globally, symptomatic OA (typically affecting the hip and knee) is estimated to affect approximately 240 million people[2]. A meta-analysis conducted in China, including 74.908 participants across 21 studies, reported an overall prevalence of 14.6% for OA,

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with prevalence increasing with age. The study also found that the prevalence of OA was higher in women (19.1%) compared to men (10.9%)[18]. Similarly, a demographic study conducted in Korea with 12,287 participants found that the prevalence of radiographic OA among individuals aged 50 and above was as high as 35.1%, with the prevalence being higher in women compared to men[19].

Regional studies report varying prevalence rates for KOA, but these figures must be interpreted according to their diagnostic criteria. In Türkiye, the prevalence of symptomatic KOA was reported as 20.9% among individuals aged 40 and above[20]. Another study reported a symptomatic KOA prevalence of 22.5% in women and 8% in men[21]. The discrepancy between these values is attributed to methodological differences, such as the age inclusion criteria. Similarly, a comprehensive meta-analysis in China identified an overall symptomatic prevalence of 14.6%[18]. In contrast, the Korea National Health and Nutrition Examination Survey indicated a much higher prevalence of 35.1% because it recorded radiographic OA, which identifies structural joint changes regardless of the presence of clinical symptoms[19].

Studies have investigated the risk factors for OA and have found consistent associations with factors such as age, gender, body weight changes and obesity, history of injury, occupational physical demands, physical activity, joint malalignment, muscle strength around the joint, lifestyle, geographic regions, and genetics[11,22]. Due to the decreasing levels of physical activity, increasing prevalence of obesity, and longer life expectancy, it is expected that the frequency of OA will rise in the coming years[18].

Treatment Methods

In patients with KOA, the goals are to control symptoms, prevent the progression of joint damage, improve quality of life, and increase the level of functional independence. Factors such as age, physical condition, comorbidities, severity of symptoms, patient preferences, and treatment costs should be considered when determining treatment options. Treatment consists of non-pharmacological (conservative), pharmacological, and surgical methods when necessary. An individualized treatment plan should be created for each patient[23].

Among conservative treatments, physiotherapy, which includes structured exercise programs, is considered a fundamental component in the management of KOA[2]. Physiotherapy applications include physical therapy agents such as laser, ultrasound, electrotherapy, heat and cold applications, and exercise programs[24]. Research consistently supports the role of physiotherapy in improving joint function, reducing pain, and enhancing overall quality of life[25].

However, access to traditional face-to-face rehabilitation is often limited due to barriers such as geographic location, financial constraints, and mobility limitations, preventing many patients from receiving the necessary care[26]. In response to these challenges, TR has emerged as an alternative, utilizing digital technologies to deliver rehabilitation programs remotely.

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Telerehabilitation

TR is the provision of rehabilitation services to patients in remote locations using information and communication technologies[27]. TR employs various technologies, including virtual reality, mobile applications, artificial intelligence, tablets, mobile games, online video conferences, and other methods to deliver rehabilitation services[28]. TR has been applied in cardiac rehabilitation, cancer rehabilitation, neurological rehabilitation, spinal cord injuries, musculoskeletal disorders, and depression treatment[29].

TR encompasses a wide range of services, including guided exercise programs, educational resources, and real-time feedback from healthcare providers via telecommunication platforms[30]. This approach offers various advantages, such as increased accessibility, convenience, and the provision of continuous, personalized care, which are particularly beneficial for chronic conditions like KOA[31]. Additionally, TR enables healthcare providers to monitor patient progress and adjust treatment plans accordingly, thereby delivering a more individualized treatment experience[32]. The successful implementation of TR depends on patients' access to telecommunication technology and their familiarity with its use. Therefore, TR outcomes may vary based on country and socioeconomic status[33].

Advantages and Disadvantages of Telerehabilitation

Advantages provided by TR include reducing hospitalization rates and preventing readmissions, enabling early discharge from rehabilitation units, lowering costs and saving time, providing rapid access to outpatient rehabilitation services, allowing flexible planning of the intensity, frequency, and duration of rehabilitation programs according to patient needs, controlling costs, reducing waiting lists, and ensuring sufficient and continuous service delivery in both acute (e.g., postoperative) and chronic (e.g., degenerative diseases) conditions. Additionally, supporting early return to work and improving health outcomes and quality of life are other significant contributions[34].

TR also has some disadvantages. The inability to perform palpation and other special tests used as diagnostic tools during clinical examination may limit the assessments conducted with this method. Therefore, especially in complex clinical cases, it is preferred that the initial evaluation session be conducted face-to-face, taking into account past clinical findings. Additionally, access to rehabilitation equipment such as elastic bands, balls, and weights is limited in TR services. This situation poses a disadvantage in planning the rehabilitation program. To address such limitations, physiotherapists may need to identify the necessary equipment for participation in therapeutic exercises in advance and have these tools delivered to the patient’s home. Furthermore, certain elements of the clinical environment are lacking in TR. To compensate for these deficiencies, verbal communication (explanations, clear instructions, and supportive expressions) and body language (positive nodding, eye contact, etc.) must be used effectively[33].

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TR reduces costs, saves time, and increases accessibility. However, the inability to perform palpation and the lack of clinical equipment at home are significant disadvantages.

Cost-Effectiveness of Telerehabilitation

As a newly developing field, there is a need to conduct cost analysis as well as evaluate clinical outcomes related to TR[35]. The cost of TR interventions includes the cost of technological devices such as smartphones or computers, the internet service required for communication, and the cost of the professional services provided[36]. The cost of traditional face-to-face rehabilitation interventions includes the cost of the professional services provided, the travel expenses of the patient and their caregiver, and other costs[37]. It is evident that increasing the distance between the patient's residence and the rehabilitation center raises the cost of traditional rehabilitation interventions. When the patient's distance to the rehabilitation center exceeds 30 kilometers, the cost differential between traditional rehabilitation and TR increases by 18%, and when the distance reaches 50 kilometers, this increase rises to 123%. From this perspective, saving time and money spent on travel may allow for an increase in the budget allocated for rehabilitation services. Therefore, considering cost-effectiveness in appropriate patient selection for TR would be beneficial[38].

Discussion

Telerehabilitation-Based Exercises in the Management of KOA

TR systems include video conference-based, sensor-based, and virtual reality-based technologies[39].

Video conference-based TR is a way to connect the clinician and the patient for a clinical purpose consisting of assessment and/or treatment, allowing the patient to exercise at home under the real-time supervision of a physiotherapist[40]. It is a basic TR system based on image and sound transmission between the physiotherapist and the patient[39,41,42].

Sensor-based TR is somewhat more complex than video conference-based TR. In this system, wearable devices equipped with sensors such as inclinometer sensors, accelerometers, and gyroscopes are used to assess the patient's movements. Additionally, activity tracking devices that do not require the patient to wear them (such as Nintendo Wii Remote®, Leap Motion®, or Kinect®) and robotic devices are also used[39,41,42].

Virtual reality-based TR systems utilize computer-generated three-dimensional virtual environments that can be configured by the patient to elicit specific movements and motor responses[42]. Through intermediary devices, the computer makes changes in the virtual graphical environment based on the user's actions (voice input, movement, etc.). Thus, it creates the illusion of the user's interaction and intervention within the virtual reality[42-44]. When reviewing the literature, it has been observed that TR applications in patients with KOA mostly involve video conference-based TR.

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In a study conducted by Aily et al. in 2023, 100 adult participants with KOA underwent circuit training lasting 25-45 minutes, three times a week for 14 weeks. The participants, randomly divided into two groups, were given the same exercise program either through TR (remote video recordings + telephone follow-up) or face-to-face. This study found TR to be as effective as face-to-face circuit training for pain and muscle strength. However, from a critical perspective, the researchers noted that the asynchronous model inherently allows for less interaction between the clinician and the patient compared to synchronous models. Furthermore, while adherence was high, the TR group's data relied on self-reported diaries, which may be prone to overestimation of actual exercise compliance[45].

In their study with 48 individuals diagnosed with KOA, Kim et al. provided participants with exercise programs either through face-to-face visits or remotely via TR for eight weeks in randomly assigned groups. The study found that participants in both the face-to-face and TR exercise programs showed improvements in walking speed, knee function, and health-related quality of life. There was no significant difference between the TR exercise group and the face-to-face exercise group in improving knee joint function and health-related quality of life; however, the face-to-face group demonstrated a significantly greater increase in gait speed compared to the TR group. Based on these findings, it was emphasized that TR exercise programs for patients with KOA can complement face-to-face exercise programs, highlighting that TR should be used not only as an alternative complementary program but also as an intervention method for various diseases[46].

Another study examined the effectiveness of a 4-week supervised TR program delivered via video calls compared to conventional rehabilitation. The findings indicated that TR is a valid and effective alternative to conventional therapy for reducing pain and improving functional scores. Nevertheless, several methodological limitations must be considered: the study had a relatively small sample size (n=55) and a short follow-up period of only three months, which limits the ability to assess the long-term sustainability of the results. Additionally, the TR group was found to be significantly more physically active at baseline than the control group, which may have introduced a selection bias regarding treatment adherence and outcomes[47].

As a result of a systematic review and meta-analysis investigating the effectiveness of different TR applications in the treatment of OA, it was found that internet-based rehabilitation is a promising strategy for patients with KOA. Compared to conventional rehabilitation, it may improve pain in KOA patients but does not enhance physical function. Additionally, TR was found to be beneficial for delivering home-based rehabilitation exercises in patients with KOA, thereby reducing the economic burden on healthcare. However, it was also noted that there is currently relatively limited research on the effects of TR on KOA[31].

In a review study focusing on technologies and teleservices for TR in patients with KOA, it was emphasized that video-based TR programs can be considered the best alternative solution to conventional treatment. The study also showed that, due to rapid

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advancements in sensor technologies in recent years, sensor-based solutions have been gaining increasing popularity. However, it was noted that communication and human-delivered feedback remain just as important as monitoring and intervention services[30].

Another systematic review also reported that TR is a promising alternative method, especially for KOA patients who face barriers in accessing face-to-face therapy. It was found to be effective in reducing pain and improving strength and balance; however, its success was noted to depend on patient engagement, the delivery of the intervention, and adherence to rehabilitation protocols. Additionally, it was emphasized that therapist-guided programs yield better outcomes compared to self-managed approaches[48].

The clinical efficacy of TR is further supported by a large-scale systematic review and meta-analysis conducted by Cottrell et al., which analyzed 13 studies involving 1,520 participants with various musculoskeletal conditions. This review provides compelling evidence that real-time (synchronous) TR is effective in improving physical function and reducing pain. Specifically, for populations following total knee arthroplasty -a condition closely related to advanced KOA- the meta-analysis demonstrated that TR is equivalent and not inferior to conventional face-to-face models of care. However, a nuanced finding of this synthesis is that while TR as a "stand-alone" treatment is comparable to face-to-face care, TR delivered in addition to usual care may yield even more favorable results for physical function[49].

The review highlights that while blinding of participants and clinicians is often impossible in these trials, this methodological limitation introduces a substantial risk of bias regarding the study's internal validity[49]. Specifically, the lack of blinding can lead to overestimation of treatment effects or inflated self-reported outcomes. Nevertheless, the consistency of findings across various musculoskeletal conditions suggests that TR remains a viable clinical option, especially when blinded outcome assessors are utilized to mitigate these potential biases[45,47,49].

Comparative Efficacy: Telerehabilitation vs. Face-to-Face Treatment

While TR is broadly supported as a viable alternative, it is critical to note that face-to-face treatment may be superior in specific clinical parameters. For instance, Kim et al. found that while both TR and face-to-face groups improved, the face-to-face group demonstrated a significantly greater increase in gait speed compared to the TR group[46]. This disparity is attributed to the therapist's ability to provide immediate physical touch and real-time manual corrections. Furthermore, a large-scale meta-analysis by Xiang et al. concluded that while TR effectively reduces pain, it may not improve physical function as effectively as conventional rehabilitation[31]. Furthermore, Kloek et al. reported that while both methods are effective, reducing face-to-face sessions in a blended model does not necessarily yield superior functional outcomes compared to standard care[50].

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Practical Implications

To maximize the effectiveness of TR in KOA management while acknowledging current evidence heterogeneity, the following practical considerations are suggested[45,47,51-54]:

Disease Stage: TR appears to be the most effective for individuals in the early to moderate stages of KOA, specifically those classified as Kellgren-Lawrence (KL) grades I, II, or III.

Frequency and Duration: Successful protocols typically utilize a frequency of 3 sessions per week. The total duration for a significant clinical effect ranges from 4 to 14 weeks. Sessions should last between 20–25 minutes for focused exercise protocols and up to 45–60 minutes when including comprehensive education and warm-up components.

Telerehabilitation Method: While various models exist, synchronous video conferencing with direct physical therapist contact is often highlighted as among the most effective TR modalities for reducing pain and functional disability because it facilitates real-time professional supervision and immediate feedback.

Critical Discussion and Methodological Limitations

A critical synthesis of current research reveals several methodological limitations that impact the generalizability of TR findings.

Blinding: Due to the physical nature of exercise, blinding of participants and therapists is not possible, which introduces a substantial risk of performance and expectancy bias. While outcome assessors can be blinded, this was only achieved in roughly half of the reviewed trials[47,49].

Sample Size and Follow-up: Many studies are characterized by small sample sizes (e.g., n=48, to n=55), which may limit statistical power and the generalizability of results. Furthermore, short follow-up periods (typically 3–6 months) prevent a clear understanding of the long-term sustainability of TR outcomes[28,47].

Inter-study Heterogeneity: There is a very high degree of heterogeneity regarding technological platforms (e.g., Zoom, WhatsApp, specialized apps), exercise types, and patient baseline activity levels, making it difficult to establish a universal standard of care[31,47].

Reporting Bias: In asynchronous or self-managed models, adherence data often rely on self-reported diaries, which are prone to overestimation of actual compliance[45].

Conclusion and Suggestions

In conclusion, TR has increasingly been used and become a potentially cost-efficient tool in the management of KOA. Current literature suggests that TR is a viable and generally comparable alternative to face-to-face treatment, offering significant improvements in pain relief and patient-reported quality of life. However, it is essential to express these

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findings with caution due to the high degree of inter-study heterogeneity regarding technological platforms and exercise types. Furthermore, TR may have limitations in improving specific motor functions, such as gait speed, where face-to-face interventions remain superior due to immediate manual feedback and physical contact. TR may offer a promising option in the management of KOA, especially for individuals who experience difficulties accessing in-person treatment. The use of multiple technologies in combination can make treatment more engaging, encourage patients to remain committed to the process, and enhance outcomes. While short-term outcomes are promising, the long-term sustainability of these benefits remains uncertain. Future research should focus on standardizing protocols and evaluating the long-term sustainability of these digital interventions.

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