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The effect of telerehabilitation on improving the physical activity of patients with osteoarthritis: A systematic review

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Abstract:

This systematic review aimed to evaluate the effect of telerehabilitation on improving physical activity, physical function, and quality of life in patients with osteoarthritis (OA). A systematic review of randomized controlled trial studies was conducted without a time limit by searching for keywords in the title, abstract, and study keywords in the scientific databases Embase, Web of Science, Scopus, and PubMed on October 20, 2021. This study was conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines. Titles and abstracts were retrieved based on the inclusion, exclusion, and quality assessment criteria. Then, full texts were retrieved and reviewed independently by two separate authors based on the eligibility criteria. Disputes were resolved through discussion. A form with the same predefined elements was used to extract data. Totally, eight eligible articles were found through this review. The studies on telerehabilitation approaches were categorized into three categories, which are: home-based exercise programs by online mobile applications, sports counseling and physiotherapist support via telephone calls, and Internet-based exercise training (IBET). In four studies (57%), telerehabilitation was effective in the short term for some months and improved the performance, self-efficacy, and quality of life of participants. On the other hand, in the long-term effects, there was no difference in participants' improvement (43%). In long-term follow-up, there was no difference between the efficiency of traditional rehabilitation and telerehabilitation in improving the physical performance and quality of life. However, telerehabilitation can be a viable alternative to traditional physiotherapy in patients with OA.

Keywords:

Exercise, osteoarthritis, telemedicine, telerehabilitation

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Introduction

Osteoarthritis (OA) is the most prevalent chronic condition of the knees. The worldwide prevalence estimates for OA are about 13% in women and 10% in men aged 60 years and older.[1,2] Thus, the demand for health services increases. Over time, knee OA causes pain, inactivity, and thereby negatively affects the quality of life of patients.[3] Often, immobility caused by knee OA causes obesity, which increases the problems and complications caused by OA because obesity increases the load on the knee joint due to the heavy weight that the knee bears.[4]

Physical therapist intervention consisting of muscle strengthening exercises and patient education has shown to be effective in reducing the levels of pain and improving physical functioning.[5] These therapeutic strategies may also have beneficial effects on a person's mental and behavioral health.[6] In this regard, the American College of Sports

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Medicine states that "exercise is medicine." It continues that exercise, which includes both aerobic and resistance exercises, is an effective interventional recommendation for the treatment of knee OA.[5]

Traditional (face-to-face) physical therapy sessions are costly for many people and their access is restricted by geography.[7] Telerehabilitation is a promising strategy, particularly for the early stage of a remote therapeutic exercise program.[8] Telerehabilitation provides rehabilitation services using various technologies, including virtual reality, mobile phone applications, artificial intelligence, iPad, mobile games, online video conferencing, and others.[9-14] Previous studies have shown that telerehabilitation is effective, safe, and feasible in patients with chronic obstructive pulmonary disease,[15] patients with coronavirus disease 2019 (COVID-19),[16] and patients undergoing chemotherapy.[17] Also, Baigi *et al*.[18] reported that telerehabilitation services are more cost-effective and, at the same time, have the same treatment results compared to traditional (face-to-face) rehabilitation. On the other hand, Jiang *et al*.[19] reported in their systematic review and meta-analysis that telerehabilitation for patients after knee arthroplasty, in contrast to traditional rehabilitation, had a better effect on functional improvement and subsequently the quality of life of patients. Due to the moment-to-moment access to treatment, telerehabilitation improves treatment compliance, reduces trips to the doctor's office, and ultimately improves patient satisfaction.[20] A recent systematic review found that telerehabilitation improved treatment adherence and may offer promising results.[21]

To date, many studies have investigated the effect of telerehabilitation in patients with OA. However, randomized controlled trials (RCTs) provide the strongest evidence in any field. Therefore, this systematic review of RCT studies was conducted with the aim of evaluating the effect of telerehabilitation on improving physical activity, physical function, and quality of life in patients with OA. In other words, we are looking to investigate the effect of telerehabilitation compared to traditional (face-to-face) rehabilitation in patients with OA. To address the objective, the Population, Intervention, Comparison and Outcomes PICOS criteria were set, as outlined in Appendix 1.

Materials and Methods

Study design

This study was conducted according to Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines to report on evidence from the studies that were included in this systematic review.[22,23] This study was approved by the ethical committee of Mashhad University of Medical Sciences (approval number IR.MUMS.REC.1400.296). We conducted a literature search without a time limit on the PubMed, Embase, Scopus, and Web of Science databases on October 20, 2021. The following keywords and MeSH terms were used to conduct the databases search: ("physical therapy modalities," "exercise therapy," " physical therapy," "physiotherapy," "exercise") AND ("telemedicine," "telerehabilitation," "telehealth," "mobile health," "eHealth," "mHealth"). The "randomized control trial" filter was applied to the search strategy. All articles from the systematic search were collected, and duplicate articles were excluded from this study. Titles and abstracts were retrieved based on the inclusion, exclusion, and quality assessment criteria. Then, full texts were retrieved and reviewed independently by two separate authors based on the eligibility criteria. Disputes were resolved through discussion.

Eligibility criteria

Studies were included if they met the following inclusion criteria: original RCTs that used telerehabilitation or tele physiotherapy modalities to improve the physical function and physical activity in patients with OA. On the other hand, the exclusion criteria were 1) type of publication other than journal articles (e.g., books, review papers, and letters); 2) lack of availability of the full text in the English language; and 3) lack of relation of the title, abstract, or full text of the papers to the aim of the study.

Data extraction and synthesis

A form with the same predefined elements was used to extract data. The data items in this form included the following: publication title, first author's name, publication year, participants' characteristics, study design, the telerehabilitation approach that was used, intervention characteristics, study goals, and main study findings.

Quality assessment

The evaluation of the quality of the included studies in this review was done using the evaluation checklist of the Joanna Briggs Institute (JBI) for RCTs.[24] This checklist contains 13 questions for evaluating RCT studies, for example, questions such as blinding of the researcher, participants, analyst, how to randomize, data analysis, and so on. If the answer to a question was "yes," it was scored "1," and otherwise, it was scored "0." As a result, the maximum quality score of the included studies was 13, and studies with an evaluation score of less than 7 were excluded from this systematic review.

Results

Study selection

As shown in Figure 1, in total, 2142 documents were initially retrieved through scientific database searching and three documents from gray literature searching, 683 of which were duplicates. Among the retrieved articles, 83 documents were excluded after the title and abstract

screening. Finally, eight eligible articles were found through this review.

Quality assessment

Table 1 shows the result of the quality assessment of the included studies. There was no significant bias in the studies, and most of the included studies were of moderate to high quality. Therefore, all RCT studies were included in this systematic review.

Study characteristics

This review included 8 eligible studies.[25-32] The characteristics of all included studies are reported in Table 2. Of the eight included studies, three (30%) studies were conducted in Australia[26,29,30] and other studies in Taiwan,[27] the Netherlands,[28] Saudi Arabia,[25] Iran,[31] and the USA.[32] Studies' sample sizes ranged from 40[25] to 350 participants.[32] The average or median age of participants ranged from 54.4[25] to 65.3 years.[32] Study designs were classified into two categories: RCTs (7/8, 87.5%)[25-27,29-32] and cluster RCT (1/8, 12.5(.[28] Follow-up periods ranged from 6 weeks[31] to 12 months.[26,28,32]

Telerehabilitation approaches

As shown in Table 3, telerehabilitation approaches included studies that were categorized into three groups: of the eight studies, two (25%) used home-based exercise programs by online mobile applications,[25,28] four (50%) used sports counseling and physiotherapist support via telephone calls,[26,27,30,31] and two (25%) used Internet-based exercise training (IBET).[29,32] These programs provide guidance on exercise performance and exercise movements. For example, isometric quadriceps contractions, isotonic quadriceps contractions, isotonic hamstring contractions, resistance band isotonic quadriceps contractions, straight leg raises, lateral hip abductions, partial squats, dynamic stepping exercises, side steps with resistance around the thigh or ankle, etc., These programs support features such as alerts and a monitoring system controlled by the physiotherapist. It also offers automatic recording of exercise adherence, including time and sessions completed. Hence, it enables the physiotherapist to monitor the participant's adherence to the prescribed exercises.

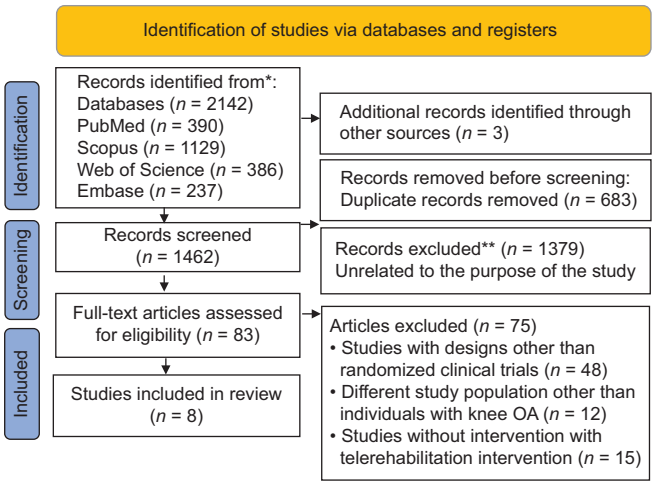

Figure 1: Flow diagram of the literature search and study selection

Effects of telerehabilitation on patients with OA

In three studies, no significant differences were reported between traditional (face-to-face) physiotherapy and telerehabilitation approaches in improving participants' performance.[28,31,32] In addition, in one study, the effect of telerehabilitation as an adjunct intervention along with face-to-face physiotherapy counseling was measured, but there was no significant difference in improving the physical function in participants between the control and intervention groups.[30] However, in three of the studies, the results showed better improvement in performance and reduction of pain in the telerehabilitation approach.[25,27,29] Also, one study supported the short-term effects of an exercise program with a telerehabilitation approach.[26]

Discussion

Principal findings

This systematic review aimed to evaluate the effect of telerehabilitation on improving physical activity, physical function, and quality of life in patients with OA. The results of the systematic review showed that telerehabilitation was effective in the short term (3–4 months) and improved the performance, self-efficacy, and quality of life of participants.[25-27,29]

Table 1: Results of quality assessment of the included studies based on the JBI checklist for RCTs

Reference	1	2	3	4	5	6	7	8	9	10	11	12	13	Quality assessment score
[25](2020, Saudi Arabia)	Y[a]	Y	Y	N[b]	N	N	Y	Y	Y	Y	Y	Y	Y	10
[26](2020, Australia)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10
[27](2021, Taiwan)	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	11
[28](2018, The Netherlands)	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	10
[29](2018, Australia)	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	10
[30](2017, Australia)	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	10
[31](2017, Iran)	Y	N	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	8
[32](2018, USA)	Y	N	Y	Y	N	N	Y	Y	N	Y	Y	Y	Y	9

JBI=Joanna Briggs Institute, RCT=randomized controlled trial. [a]Y=Yes. [b]N=No

Table 2: Summary of study characteristics of participants from all included studies

Reference	Participants' characteristics		Duration of interventions
	Number of participants	Mean age of participants	
[25](2020, Saudi Arabia)	40	54.4	14 weeks
[26](2020, Australia)	175	62.45	12 months
[27](2021, Taiwan)	66	65.26	12 weeks
[28](2018, The Netherlands)	208	62.9	12 months
[29](2018, Australia)	148	60.8	9 months
[30](2017, Australia)	168	62.25	6 months
[31](2017, Iran)	54	55.5	6 weeks
[32](2018, the USA)	350	65.3	12 months

Alasfour *et al*.[25] conducted a study with the aim of investigating the effects of an Arabic smartphone application on adherence to home exercise programs and its effectiveness on improving pain, physical function, and muscle strength of the lower limbs in older women with knee OA. They concluded that at the end of the sixth week, the intervention group was more adherent to the treatment. They also stated that the adherence rate in the intervention group was better due to the features of the remote rehabilitation program, the patient's adherence to exercise at home requires behavioral changes, and the features of the program can have the potential to change the patient's behavior. These features include automatic reminders to follow the program, a physical therapist monitoring system that promotes better adherence to treatment.[25] Also, Hinman *et al*.[26] reported that physical therapist-led exercise advice and support over the phone moderately improved patients' physical activity, but this improvement was not maintained at 12 months.

This may be justified in this way. Just as the body gets used to a drug after a while and no longer responds to it, a monotonous telerehabilitation intervention loses its appeal to its users after a short period of time. Therefore, as Mousavi *et al*.[15,16] stated in their recent study, the use of multiple technologies in combination may have a better effect than a program based on one technology.

Pérez-Manchń *et al*.[33] stated that asynchronous telemedicine can be an efficient way to provide remote health-care services. However, this method still requires the active participation of therapists to review the videotaped session. Sensor-based telerehabilitation programs are more independent services than video communication, as they use one or more sensors to record the patient's physical activity and collect motion data using software that runs on a computer device (computer, smartphone, tablet). Ayoade and Baillie[34] demonstrated that a sensor-based telerehabilitation program can increase flexibility and time independence for patients using semi-supervised training sessions.

On the other hand, interactive telerehabilitation can provide real-time graphical feedback of the patient's performance using software, enabling users to review their performance over time.

Recent studies have shown that the expert system can partially or completely interact with the patient and assume the responsibilities of the therapist.[35,36]

Russell[37] also identified telerehabilitation programs based on virtual reality as a mode of telerehabilitation. On the other hand, colleagues found that video-based remote rehabilitation programs can be considered the best alternative solution to conventional treatment. Allegue *et al*.[38] also stated that a combined approach of telerehabilitation may have a better effect than single interventions.

On the other hand, in the long-term effects (9–12 months), there was no difference in participants' improvement.[28,30,32] Kloek *et al*.[28] reported that no significant difference was observed in the functional status of patients in both groups (in-person physical therapy vs. in-person physical therapy plus online exercise program), However, the participants in the physical therapy group attended 12 sessions and the participants in the intervention attended only five sessions. This reduction in face-to-face visit sessions may lead to a reduction in patient rehabilitation costs.

On the other hand, telerehabilitation is a cost-effective, safe, efficient, and feasible approach.[25-30,32,39-49] The type of telerehabilitation approach was simultaneous in all interventions and did not show a difference in performance or physical improvement.

In line with the results of this study, Latif-Zade *et al*.[50] conducted a systematic review to evaluate the effectiveness of telerehabilitation in reducing pain in patients with OA of the knee. The results of three RCT studies obtained by them showed that telerehabilitation has a similar efficiency in reducing pain in people with OA. In addition, Jansson *et al*.,[51] in their systematic review, concluded that patients who completed telerehabilitation showed an improvement in physical function, which was similar to that of patients who underwent routine outpatient physiotherapy, without increased side effects or resource use. However, the effect of telerehabilitation on physical performance was assessed as a heterogeneous evidence of moderate to low quality.

Strengths and limitations

This study was the first systematic review of RCT studies to investigate the effect of telerehabilitation on improving physical activity, physical function, and quality of life in patients with OA. One of the limitations of this

Table 3: Summary of characteristics of all included studies

Reference	Study goals	Telerehabilitation approach	Study results	Study conclusions
[25](2020, Saudi Arabia)	The effects of an Arabic smartphone application on adherence to home exercise programs and the effectiveness of these programs on pain, physical function, and muscle strength of the lower extremities in elderly women with osteoarthritis of the knee	Smartphone application	The intervention group was more committed to home exercise programs (*P*=002) and reported a significant reduction in pain (*P*=015)	A mobile phone-based app with motivational and engaging features can increase adherence to HEPs in patients with knee OA. Mobile phone-based applications supported by attractive and motivational features can be an effective strategy to increase HEP adherence among elderly with knee OA
[26](2020, Australia)	Evaluation of telephone exercise recommendations and physiotherapist supportive intervention for people with knee OA	Telephone consultation with physiotherapist consultation to receive a personal plan	At 6 months, exercise counseling and support improved performance (mean difference 4.7), but overall pain did not improve (0.7). At 12 months, most results were similar between groups	Exercise advice and physical therapist support over the phone improved the physical performance of patients with knee OA, but the joint outcome of knee pain at 6 months was not sufficient. Functional benefits were not maintained at 12 months. The clinical significance of this effect is unclear
[27](2021, Taiwan)	Evaluation of the effects of nutrition-based resistance interventions and telemedicine at home on improving body composition, blood biochemistry, and functional activity of the lower extremities	Diet control plus elastic band exercise group (D+E) via telephone calls or a communication application	After 12 weeks of intervention, the control group (*P*<0.001) and the intervention group (*P*<0.001) achieved significant weight loss	A personalized diet control intervention combined with a telemedicine-based resistance training intervention effectively improved body composition, blood biochemistry, and functional activity of the lower limbs in patients with knee OA
[28](2018, the Netherlands)	Evaluation of short-term and long-term efficacy of e-exercise in comparison to conventional physiotherapy in people with hip/knee OA	Online mobile application	No significant difference in initial outcomes was found between the e-exercise group and the conventional physiotherapy group	The combined intervention, e-exercise, was no more effective than conventional physical therapy in subjects with hip/knee OA. However, within-group differences showed that both interventions were significantly effective with regard to physical function and most secondary outcomes immediately after treatment and after 12 months. Reducing face-to-face meetings may lead to lower health-care costs
[29](2018, Australia)	Evaluation of the effect of an Internet-based intervention on changes in pain and physical function in people with OA of the knee	Internet training + online interactive automated pain-coping skills training program	The intervention group had significantly more pain reduction at 3 months than the control group (*P*=0.02)	Patients who were employed and had higher self-efficacy at baseline were more likely to experience greater improvement in pain at 3 months after an Internet-based exercise, education, and pain-coping skills program. The results support the effectiveness of Internet-based care for a wide range of people with knee

Contd...

Table 3: Contd...

Reference	Study goals	Telerehabilitation approach	Study results	Study conclusions
				OA, but future confirmatory research is needed
[30](2017, Australia)	Investigate whether simultaneous telephone coaching improves the clinical effectiveness of a physiotherapist-prescribed home-based physical activity program for knee OA	Five 30-min consultations with a physiotherapist + telephone coaching sessions	Change in pain and physical function at 6 months did not differ between groups. However, both groups showed clinically relevant improvements. Some secondary outcomes related to physical activity and exercise behavior favored coaching at 6 months, but not overall at 12 or 18 months. There were no between-group differences in most other outcomes	Adding concurrent telephone coaching did not increase the pain and performance benefits of a physical therapist-administered home-based physical activity program. However, a mobile phone program improved patient adherence
[31](2017, Iran)	Comparison of the efficacy of telerehabilitation to OBPT in patients with knee OA	Telerehabilitation (pamphlet containing descriptions and pictures detailing and phone call)	There was no significant difference between telerehab and OBPT groups in any of the studied scales	Telerehabilitation program is as effective as OBPT in improving the function of patients with knee OA. Due to the much lower time and cost involved in telerehabilitation, this program is recommended for the older population living in remote locations
[32](2018, the USA)	Comparison of the effectiveness of physical therapy (evidence-based approach) and IBET, each vs a WL control, among individuals with knee OA	IBET	Similarly, at 12 months, the mean differences compared to WL were not statistically significant for either group. IBET was noninferior to physical therapy at both time points	There was no significant difference between the investigated outcomes in the two groups. Further studies are needed to investigate strategies to maximize the benefits of exercise-based interventions for patients with knee OA

IBET=Internet-based exercise training, OA=osteoarthritis, OBPT=office-based physical therapy, WL=waitlist, HEPs=Home-based exercise programs

systematic review was the small number of included studies, which makes definitive conclusions impossible. Also, the included studies used different methods to measure telerehabilitation outcomes. Therefore, it was not possible to conduct a meta-analysis and examine the effect of these studies as a group.

Conclusion

This review shows that in recent years, technology-based solutions have also become more popular due to rapid advances and improved patient adherence to treatment. Especially for improving the physical activity and subsequently the quality of life of patients with knee OA, one of the most important requirements that helps in their recovery is long-term adherence to the treatment process. Although in the short term, the follow-up of patients with knee OA in the remote rehabilitation group showed a better improvement in the physical activity compared to traditional rehabilitation, these results were not maintained in the long term. The use of combined technology approaches may improve these outcomes by increasing attractiveness and encouraging patients to adhere to treatment. However, future studies are needed to confirm this.

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Author's contributions

Conceptualization and Design: SFMB, MS. Literature search: SFMB, KK. Data acquisition: KGH, MRM, ASM. Screening and analysis: KK, ASM. Manuscript preparation: SFMB, KGH. Manuscript editing: KK, MS. All authors read and approved the final version of the manuscript.

Compliance with ethical guidelines

This study was approved by the ethical committee of

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Conflicts of interest
There are no conflicts of interest.

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Appendix 1: PICOS Criteria

Criteria	PICOS question
Population	Patients with OA
Intervention	Telerehabilitation interventions
Comparison	Standard (face - to – face) care procedures.
Outcomes	The outcome of physical activity, physical function and quality of life related to the use of telerehabilitation interventions
Study	Randomized controlled trials