Kinestetik : Jurnal Ilmiah Pendidikan Jasmani 7 (4) (2023)
Kinestetik : Jurnal Ilmiah Pendidikan Jasmani
https://ejournal.unib.ac.id/index.php/kinestetik/index
DOI : 10.33369/jk.v7i4.30588

The Effectiveness of Telerehabilitation on Improving Knee Function in Patients with Osteoarthritis Knee: A Systematic Review and Meta Analysis

Yunita Rahayu Pratiwi [1], Suryo Saputra Perdana *[2]
[1,2] Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, Surakarta , Indonesia

Article Info

Article History :

Received : October 2023

Revised : December 2023

Accepted : December 2023

Keywords:

Elderly,
Knee function,
Osteoarthritis Knee,
Telehealth,
Telerehabilitation,

Abstract

Knee Osteoarthritis (KOA) is one of the leading causes of limitations in performing activities that impact in impaired knee function and mobility, necessitating physiotherapy intervention. Advancements in current technology have made it possible to receive treatment without the need for in-person meetings. This study aims to assess the feasibility of telehealth physiotherapy in improving knee function in OA patients. The design of study is Systematic Review and Meta-Analysis, with study sources obtained from Scopus, ProQuest, and PubMed databases using keywords based on the PICO framework. Data analysis was performed using Review Manager. The study identified a total of 1.726 articles, with a final screening resulting in 5 articles that were further examined. Each study had a Randomized Control Trials (RCT) research design and was oriented towards comparing telehealth with face-to-face interventions. Telerehabilitation did not show significant changes due to various factors, including the study's duration, physiotherapist supervision, patient motivation and adherence, as well as the comprehensiveness of exercise instructions.

*Corresponding email : ssp741.ums.ac.id

ISSN 2685-6514 (Online)
ISSN 2477-331X (Print)

INTRODUCTION

Osteoarthritis (OA) is a disease involving various anatomical and physiological changes in joint tissues, including cartilage degradation, bone remodeling, and osteophyte formation (Allen et al., 2022). OA is the most common condition among individuals over the age of 45, with a worldwide incidence of 203 per 10,000 people annually and 13.4% in Asia (Cui et al., 2020). According to the 2018 Riskesdas results, the incidence of OA in Indonesia is 240 per 100,000 people per year. OA is most prevalent among the age group over 75 years, with a rate of 18.9%. The age group 65-74 years also has a relatively high prevalence of 18.6%, while the age group 55-64 years has a prevalence of 15.5%. This data also indicates that women are more susceptible to joint diseases, with a rate of 8.5%, compared to men with a rate of 6.1% (Kemenkes RI, 2019).

The risk of developing OA increases in the obese and elderly populations (Zhong et al., 2019). Most patients experience complaints of pain and stiffness in the morning, which worsens after strenuous activities. They also suffer from reduced joint mobility, decreased muscle strength, swelling, and locking of the knee. These limitations result in difficulties in walking, climbing stairs, performing household chores, and other activities, leading to a decreased quality of life. Patients with knee Osteoarthritis (OA) require physiotherapy interventions to restore body movement and function and enhance their quality of life. Some physiotherapy interventions that can be employed include muscle strengthening, aerobic exercises, balance exercises, resistance exercises, and muscle stretching (Mora et al., 2018). The provision of physiotherapy interventions is no longer limited to in-person meetings, thanks to the advancements in technology. This is supported by technology's transition from the 4.0 Industrial Revolution to the 5.0 New Society. This new concept has been developed by the Japanese government, emphasizing the integration of digital technology and artificial intelligence (AI) into various aspects of community life, including healthcare. One of the innovations in the healthcare field during this period is Telehealth (Fukuda, 2020).

Telehealth technology describes the remote delivery of healthcare services using information and communication technology resources, involving all professions in the healthcare sector (Tuckson et al., 2017). The goal of this technology is to enhance the patient care experience, improve population health, reduce per capita healthcare costs, and enhance the delivery of care. The tools used in this technology can include video calls, email, telephone, games, web-based telehealth, and mobile applications (Tuckson et al., 2017). The application of telehealth technology in physiotherapy interventions has been widely adopted abroad for chronic musculoskeletal conditions such as OA, shoulder hemiarthroplasty, total hip arthroplasty, sub-acute non-specific low back pain, and chronic non-specific neck pain (Lubis, 2021). However, to date, there hasn't been a specific systematic review evaluating the effectiveness of physiotherapy services using telehealth in improving knee function in osteoarthritis patients.

Based on the description, the aim of this meta-analysis review is to: (i) assess the feasibility of telehealth physiotherapy in improving knee function in patients with knee osteoarthritis, and (ii) determine the types of physiotherapy exercises that can be conducted via telehealth, identify factors influencing its effectiveness, and

understand the limitations or constraints in providing physiotherapy exercises through telehealth in cases of knee osteoarthritis.

METHODS

Design of Study

This research utilizes a Systematic Review and Meta-Analysis methodology.

Search Strategy

The literature search for this study was obtained from the internet through the Scopus, ProQuest, and PubMed databases using keywords and booelan operators (AND, OR, NOT or AND NOT). The search strategy for the databases was formulated according to the PICO framework, using the following keywords:

1. P (Population/Problem): Osteoarthritis Knee, Osteoarthritis Genu, Knee Arthroplasty, Total Knee Replacement, and Gonarthros*
2. I (Intervention): Telehealth, Telerehabilitation, Long Distance Therapy, and Telecare
3. C (Comparison): -
4. O (Outcome): Knee Function.

Selection Criteria

The study has inclusion criteria as follows:

1. Patients with knee osteoarthritis complaining of pain and functional impairment with grade I – IV.
2. The intervention provided is telehealth involving exercise.
3. Research articles with a Randomized Control Trial (RCT) study design

Meanwhile, the excluded studies have the following criteria:

1. Studies that are not in full text.
2. Examining research that applies interventions unrelated to exercise.
3. Studies conducted in languages other than English.

Data Extraction

Information extracted from each article encompasses author details, participant count, participant attributes including age, gender, and body mass index, along with an explanation of the intervention program conforming to the Consensus On Exercise Reporting Template (CERT) guidelines. The intervention outcomes reported in each study are presented in Table 3.

Data Analysis

This study categorized outcomes based on outcome measures and the timing of assessments post-intervention. The assessment timing was divided into three categories: short-term (< 3 months), medium-term (3-12 months), and long-term (>12 months) (Cohen, 1992). Statistical analysis was conducted using the Review Manager software (Version 5.4.1). Means post-intervention, Standard Deviation (SD), and sample sizes were input into the Review Manager (RevMan) to calculate Standardized Mean Differences (SMDs) along with 95% confidence intervals (95% CI) for each outcome measure. Data were pooled in meta-analysis if there were consistent outcomes and assessment timing.

Subgroup analyses were performed based on tele-rehabilitation intervention, with $p<0.05$ indicating statistical significance for all types of exercises. In high-quality studies, sensitivity analysis was conducted by interpreting effect sizes of 0.2, 0.5, and 0.8 as small, moderate, and large

heterogeneity, respectively (Higgins, 2003). Statistical heterogeneity was assessed using the I2 statistic, with values of 25%, 50%, and 75% considered low, moderate, and high levels of heterogeneity, respectively (Hahn, 2009).

Quality of Evidence

The risk of bias scores for each study is recorded in Table 1. Researchers utilized the Physiotherapy Evidence Database (PEDro) to assess potential bias in each randomized clinical trial (RCT). The PEDro scale has a reasonably good inter-rater reliability and is recognized as a valid tool for measuring methodological quality in control trials.(de Morton, 2009; Lack et al., 2015)

The PEDro scale comprises 11 items used to identify the presence or absence of methodological components in a study, resulting in a total score up to 11. This score is directly obtained from the PEDro database when available; otherwise, researchers conduct a direct assessment. In case of discrepancies in assessments, a third reviewer investigates. Studies are then classified into two categories: high quality (PEDro score >6) and low quality (PEDro score ≤6) based on pre-established criteria. No studies were excluded from quality assessment.

Table 1. Risk of bias (PEDro) Score

No	Study	Quality	1	2	3	4	5	6	7	8	9	10	11	Total
1	Ann et al	High	1	1	1	1	1	1	1	1	1	1	1	11
2	Azma et al	High	1	1	1	1	1	1	1	1	1	1	1	11
3	Doiron-Cadrin et al	High	1	1	1	1	1	1	1	1	1	1	1	11
4	Gohir et al	High	1	1	1	1	1	1	1	1	1	1	1	11
5	Hinman et al	High	1	1	1	1	1	1	1	1	1	1	1	11

RESULT

Identification and Selection of Articles

The process of article identification and selection, following the search strategy, initially yielded a total of 1,726 articles. A summary of this stage can be found in the PRISMA Flow Chart displayed in Fig 1. After the screening phase, we identified 16 full-text articles that were deemed eligible, and out of this number, 5 studies met the inclusion criteria.

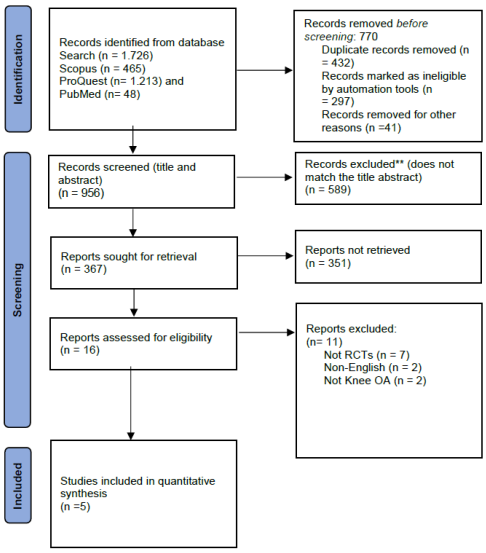

Fig 1. Search Results with The Prisma Flowchart Diagram

Study Characteristics

A summary of each characteristic and outcome is presented in Table 2. A total of 376 participants (128 males) were included in this study. The study reported Body Mass Index (BMI) with an average BMI ranging from 23 to 39 Kg/m. The severity level of Kellgren-Lawrence was approximately Grade 1 to 4. A summary of the exercise, time points, and outcomes is presented in Table 3. All studies have a commonality in providing strengthening exercises, albeit with different combinations of exercise programs. Two studies added balance exercises to their programs (An et al., 2021; Gohir et al., 2021). Three studies included Range of Motion (ROM) and flexibility exercises (An et al., 2021; Azma et al., 2018; Doiron-Cadrin et al., 2020). The method of intervention delivery was carried out asynchronously through several media. In three studies, they used telephone calls for weekly evaluations (Gohir et al., 2021),(Azma et al., 2018),(Hinman et al., 2020) Two studies utilized mobile phone applications as their medium (Gohir et al., 2021),(Doiron-Cadrin et al., 2020) One study used a website (Hinman et al., 2020) and one study conducted interventions through video calls (An et al., 2021).

The interventions and assessment time points varied, ranging from 6 weeks (An et al., 2021; Gohir et al., 2021), 12 weeks (Doiron-Cadrin et al., 2020), 6 months (Azma et al., 2018), and 12 months (Hinman et al., 2020). Some interventions evaluated short-term and medium-term outcomes, but none assessed long-term outcomes. All studies reported knee function examination results measured using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC).

Quality of Evidence

The average PEDro score is 11 (see Table 1). All five of these studies were rated as high-quality. In terms of exercise therapy, all the studies met the criteria for blinding participants or therapists. Intention-to-treat analysis was also reported by all studies.

Patient-Reported-Outcomes

The evaluation of the outcome function, reported using WOMAC measurements, included a total of 376 participants. The data indicates no significant difference between telerehabilitation and face-to-face intervention regarding knee function improvement in patients with knee osteoarthritis (-0.17, 95% CI -0.51 to 0.17) (see Fig 2).

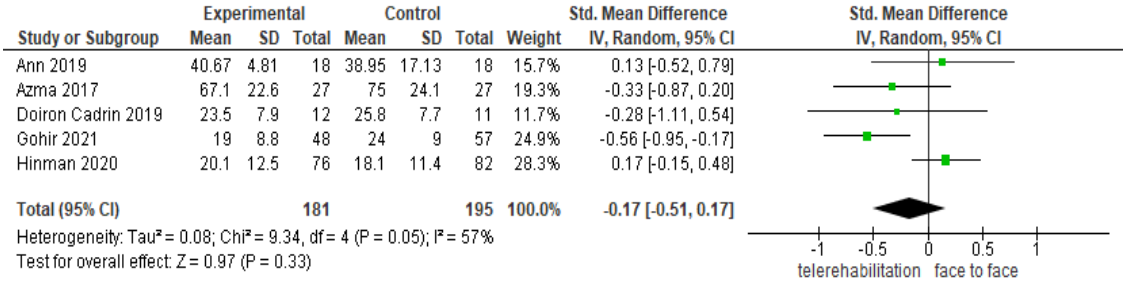

Fig 2. Forest plot of comparison: 1 Effectiveness of Telerehabilitation on Knee Function in Patients with Osteoarthritis of the Knee, outcome: 1.1 Knee Function

Table 2. Characteristics of included studies

Author	**Participants Characteristic**					**Outcome measures**
	KOA Diagnosis	N total (N males)	Age	BMI	K-L grade	Patient-reported function
Ann et al	NR, B	36 (All Woman)	71.1 ± 3.30	26.45 ± 2.50	4	WOMAC
Azma et al	ACR	54 (21)	55 ± 5.2	30.6 ± 3.75	1-3	WOMAC
Doiron-Cadrin et al	NR, U	23 (8)	69.9 ± 9.1	30.4 ±3.6	4	WOMAC
Gohir et al	NR	105 (34)	66.7±9.2	31.9 ± 5.9	1-4	WOMAC
Hinman et al	NR	158 (65)	62.5±8.1	31.2 ± 7.6	1-3	WOMAC

Table. 3 Summary reports for both intervention and control groups

Author	Telerehabilitation (Experimental Group)	Face to face (Control Group)	Intervention Duration and Type	Statistic Result (p-value)
Ann et al (An et al., 2021)	Intervention: 30 minutes per session, 3 times per day, 5 times per week. Warm up: slow walking (5 minutes) Mobility Exercise: straight leg raises, bridges, leg slides, knee press, passive ROM, and mini squats. Flexibility Exercise: extensor stretching, knee flexor stretching, and leg slides. Strengthening Exercise: Knee flexor, knee extensor, and hip abductor	Intervention: Standard care, such as following surgical procedure guidelines, monitoring postoperative progress, determining discharge goals, and simple quadriceps exercise interventions. These exercises are recommended to be performed multiple times a day based on the patient's condition. Evaluation: Direct evaluation by a physiotherapist.	6 weeks, N/A	0.001 (P<0.05: significant)

Author	Telerehabilitation (Experimental Group)	Face to face (Control Group)	Intervention Duration and Type	Statistic Result (p-value)
	training with medium to low-intensity elastic resistance bands, such as Thera-Band® (Hygienic Corporation, Akron, OH, USA). Balance Exercise: tandem walk and trunk rotation Education: - Evaluation: Video Call Method: Asynchronous via a two-way video call			
Azma et al (Azma et al., 2018)	Interventions: 3 times per week Strengthening, flexibility, endurance ROM exercise Education: 20 minutes before exercise application of hot pack modality Evaluation: Provision of a leaflet, logbook, and weekly phone calls. Method: Asynchronous via telephone	Interventions: 3 times per week 20-minute hot pack, 20-minute 50Hz transcutaneous electrical nerve stimulation, and ultrasonography (US) with 1MHz frequency and 1 watt/cm2 intensity for 10 minutes Exercise: Strengthening, flexibility, endurance ROM exercise Evaluation: Direct evaluation by a physiotherapist on a weekly basis.	6 month, N/A	0.959 (P>0,05: not significant)
Doiron-Cadrin et al (Doiron-Cadrin et al., 2020)	Intervention: 2 times per week, exercise program through the REACTS Lite application. range of motion exercise, strengthening, proprioceptive exercises, and cardiovascular warm-up. Education: Education includes explanations and understanding of the application of ice compression.	Intervention: The primary care from Maisonneuve-Rosemont and Santa-Cabrini hospitals Evaluation: Direct evaluation by a physiotherapist	12 weeks, N/A	0.263 (P>0,05: not significant)

Author	Telerehabilitation (Experimental Group)	Face to face (Control Group)	Intervention Duration and Type	Statistic Result (p-value)
	Evaluation: Delivered via the REACTS Lite application or Skype. Method: Asynchronous via mobile phone application.			
Gohir et al (Gohir et al., 2021)	Intervention: Exercise program via a mobile phone application Open and Closed Chain Exercise (strengthening, core stability, and balance exercise) Education: Education on the fundamentals of osteoarthritis, its treatment, self-management of symptoms, and maintaining a healthy lifestyle. Each education session is followed by a quiz to ensure participants have understood the material presented. Evaluation: Evaluation is conducted through daily email delivery or smartphone notifications or by physiotherapists through asynchronous chat or telephone during the study period. Method: Asynchronous via telephone and application.	Intervention: Treatment is provided directly by a physiotherapist based on the National Institute for Health and Care Excellence (NICE) guidelines. Evaluation: Direct evaluation by a physiotherapist	6 weeks, N/A	0.02 (P<0,05: significant)
Hinman et al (Hinman et al., 2020)	Intervention: 3 times a week Strengthening exercises and physical activities programmed via a website with hard to very hard intensity.	Intervention: Treatment is in line with the existing services provided by the Musculoskeletal Help Line (Musculoskeletal	12 month, N/A	0.097 (P>0,05: not significant)

Author	Telerehabilitation (Experimental Group)	Face to face (Control Group)	Intervention Duration and Type	Statistic Result (p-value)
	Education: The physiotherapist assists in developing a physical activity plan aimed at improving physical activity. Evaluation: Through telephone communication. Method: Asynchronous via telephone and website	Australia, Victoria, Australia). Evaluation: Direct evaluation by a nurse		

DISCUSSION

This study aims to analyze the effectiveness of telerehabilitation interventions on knee function for patients with knee osteoarthritis compared to traditional face-to-face treatment. The analysis was conducted on five studies, involving a total of 376 participants, including 128 males. All these participants had varying degrees of OA severity, ranging from grade 1 to the most severe grade 4. The exercise programs provided were diverse, including strengthening, mobility, flexibility, balance, proprioceptive exercises, and core stability.

The researchers identified and selected from a total of 1,726 articles until they found 5 articles that met the established inclusion criteria. To ensure the quality of these studies, the researchers used the PEDro scale for the identification process, and all five of these studies received a score of 11, indicating high quality. Additionally, data synthesis was conducted using the Review Manager application, resulting in two studies with a medium-term research duration (Azma et al., 2018; Hinman et al., 2020) and three other studies with a short-term research duration (An et al., 2021; Doiron-Cadrin et al., 2020; Gohir et al., 2021). Based on the meta-analysis data, the provision of telerehabilitation for knee osteoarthritis did not show significant results (P=0.33) in knee function improvement compared to face-to-face intervention, as the data indicates a p-value >0.05. Additionally, the results showed a heterogeneity based on the effect size of 0.08, indicating a high level of heterogeneity. According to the I^2 statistic, it showed a value of 57%, indicating moderate data heterogeneity.

Although the overall data shows non-significant results, when examined individually, two studies demonstrated a significant improvement in knee function through telerehabilitation within six weeks (An et al., 2021; Gohir et al., 2021). These two studies were part of the short-term research. However, the study conducted by Doiron-Cadrin(Doiron-Cadrin et al., 2020) within a short 12-week period did not show significant improvement, nor did the two studies within the medium-term period (Azma et al., 2018; Hinman et al., 2020). Based on this data, the difference in the research duration may indeed have an impact on the effectiveness of telerehabilitation. This is supported by previous research conducted by Russell et al., where they

observed significant changes in subjects who received telerehabilitation exercises within a 6-week period, as well as another study by Multani et al., which was conducted over 4 weeks (Multani et al., 2006; Russell et al., 2011).

These findings contrast with a study by Allen et al., conducted over a 6-month period, which concluded that the use of the telephone as a basis for self-management in OA was considered ineffective (Allen et al., 2010). Similarly, a medium-term 12-month study conducted on veterans to assess the effectiveness of an intervention involving patients and service providers for OA management also yielded non-significant results (Allen et al., 2016). The success of the research is not only influenced by the duration but also by several other factors, as seen in the study by Azma et al., where supervision by a physiotherapist is a crucial factor in the success of therapy as it can increase patient motivation and knowledge (Azma et al., 2018). Moreover, the success of therapy is also influenced by exercises tailored to the individual, high patient involvement, comprehensive information about the exercises, and therapy outcomes can also be influenced by internet access availability and the use of supportive applications(Doiron-Cadrin et al., 2020; Gohir et al., 2021). Therefore, telerehabilitation can be an alternative for providing physiotherapy exercises, even though it may not result in significant differences when compared to in-person therapy. As per the findings in the systematic research conducted by Adamse et al., telehealth can improve functional abilities, but the impact may not be significant when compared to in-person therapy in the case of chronic diseases.(Adamse et al., 2018) However, telerehabilitation also has advantages, such as lower costs and increased accessibility for patients living in remote areas where transportation might be a barrier to receiving treatment.

The limitations of this study include the absence of detailed exercise dosage for each exercise, and in some studies, there was limited information about the exercises provided. As a result, the authors cannot provide recommendations regarding the specific types and durations of exercises that would be effective in telerehabilitation interventions. Therefore, for future research, it is advisable to include studies that provide detailed explanations of the types and dosage of exercises, which would allow for recommendations of appropriate and effective exercise regimens.

CONCLUSION

The conclusion is the exercise programs delivered through telerehabilitation did not produce significant results. This can be attributed to several factors, including the study duration, the supervision provided by physiotherapists, patient motivation and adherence, as well as the comprehensiveness of exercise instructions. While telerehabilitation may not show significant differences in long-term treatment outcomes when compared to face-to-face interventions, it may offer advantages in terms of time efficiency, overcoming distance-related challenges, and cost-effectiveness. This flexibility in treatment delivery can be seen as a potential benefit, especially when achieving similar results as traditional care.

ACKNOWLEDGEMENT

The author would like to express gratitude to everyone involved in completing the research and in writing this article.

REFERENCES

Adamse, C., Dekker-Van Weering, M. G., van Etten-Jamaludin, F. S., & Stuiver, M. M. (2018). The effectiveness of exercise-based telemedicine on pain, physical activity and quality of life in the treatment of chronic pain: A systematic review. Journal of Telemedicine and Telecare, 24(8), 511–526. https://doi.org/10.1177/1357633X17716576

Allen, K. D., Oddone, E. Z., Coffman, C. J., Datta, S. K., Juntilla, K. A., Lindquist, J. H., Walker, T. A., Weinberger, M., & Bosworth, H. B. (2010). Telephone-Based Self-management of Osteoarthritis. Annals of Internal Medicine, 153(9), 570. https://doi.org/10.7326/0003-4819-153-9-201011020-00006

Allen, K. D., Thoma, L. M., & Golightly, Y. M. (2022). Epidemiology of osteoarthritis. Osteoarthritis and Cartilage, 30(2), 184–195. https://doi.org/10.1016/J.JOCA.2021.04.020

Allen, K. D., Yancy, W. S., Bosworth, H. B., Coffman, C. J., Jeffreys, A. S., Datta, S. K., McDuffie, J., Strauss, J. L., & Oddone, E. Z. (2016). A Combined Patient and Provider Intervention for Management of Osteoarthritis in Veterans. Annals of Internal Medicine, 164(2), 73. https://doi.org/10.7326/M15-0378

An, J. A., Ryu, H. K., Lyu, S. J., Yi, H. J., & Lee, B. H. (2021). Effects of preoperative telerehabilitation on muscle strength, range of motion, and functional outcomes in candidates for total knee arthroplasty: A single-blind randomized controlled trial. International Journal of Environmental Research and Public Health, 18(11). https://doi.org/10.3390/ijerph18116071

Azma, K., RezaSoltani, Z., Rezaeimoghaddam, F., Dadarkhah, A., & Mohsenolhosseini, S. (2018). Efficacy of tele-rehabilitation compared with office-based physical therapy in patients with knee osteoarthritis: A randomized clinical trial. Journal of Telemedicine and Telecare, 24(8), 560–565. https://doi.org/10.1177/1357633X17723368

Cohen, J. (1992). A power primer. Psychological Bulletin, 112(1), 155–159. https://doi.org/10.1037/0033-2909.112.1.155

Cui, A., Li, H., Wang, D., Zhong, J., Chen, Y., & Lu, H. (2020). Global, regional prevalence, incidence and risk factors of knee osteoarthritis in population-based studies. EClinicalMedicine, 29–30, 100587. https://doi.org/10.1016/j.eclinm.2020.100587

De Morton, N. A. (2009). The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. Australian Journal of Physiotherapy, 55(2), 129–133. https://doi.org/10.1016/S0004-9514(09)70043-1

Doiron-Cadrin, P., Kairy, D., Vendittoli, P. A., Lowry, V., Poitras, S., & Desmeules, F. (2020). Feasibility and preliminary effects of a tele-prehabilitation program and an in-person prehabilitation program compared to usual care for total hip or knee arthroplasty candidates: a

pilot randomized controlled trial. Disability and Rehabilitation, 42(7), 989–998. https://doi.org/10.1080/09638288.2018.1515992

Fukuda, K. (2020). Science, technology and innovation ecosystem transformation toward society 5.0. International Journal of Production Economics, 220, 107460. https://doi.org/10.1016/j.ijpe.2019.07.033

Gohir, S. A., Eek, F., Kelly, A., Abhishek, A., & Valdes, A. M. (2021). Effectiveness of Internet-Based Exercises Aimed at Treating Knee Osteoarthritis: The iBEAT-OA Randomized Clinical Trial. JAMA Network Open, 4(2). https://doi.org/10.1001/jamanetworkopen.2021.0012

Hahn, D. L. (2009). Importance of Evidence Grading for Guideline Implementation: The Example of Asthma. The Annals of Family Medicine, 7(4), 364–369. https://doi.org/10.1370/afm.995

Higgins, J. P. T. (2003). Measuring inconsistency in meta-analyses. BMJ, 327(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hinman, R. S., Campbell, P. K., Lawford, B. J., Briggs, A. M., Gale, J., Bills, C., Kasza, J., Harris, A., French, S. D., Bunker, S. J., Forbes, A., & Bennell, K. L. (2020). Does telephone-delivered exercise advice and support by physiotherapists improve pain and/or function in people with knee osteoarthritis? Telecare randomized controlled trial. British Journal of Sports Medicine, 54(13), 790–797. https://doi.org/10.1136/bjsports-2019-101183

Kemenkes RI. (2019). Hasil Riset Kesehatan Dasar Tahun 2018. https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf

Lack, S., Barton, C., Sohan, O., Crossley, K., & Morrissey, D. (2015). Proximal muscle rehabilitation is effective for patellofemoral pain: a systematic review with meta-analysis. British Journal of Sports Medicine, 49(21), 1365–1376. https://doi.org/10.1136/bjsports-2015-094723

Lubis, Z. I. (2021). Analisis Kualitatif Penggunaan Telemedicine sebagai Solusi Pelayanan Kesehatan di Indonesia pada Masa Pandemik COVID-19. Physiotherapy Health Science (PhysioHS), 2(2), 76–82. https://doi.org/10.22219/physiohs.v2i2.15148

Mora, J. C., Przkora, R., & Cruz-Almeida, Y. (2018). Knee osteoarthritis: pathophysiology and current treatment modalities. Journal of Pain Research, Volume 11, 2189–2196. https://doi.org/10.2147/JPR.S154002

Multani, N. K., Singh, B., & Garg, S. (2006). Effectiveness of Telemedicine Services Integrated Into Physiotherapeutic Health Care System. Journal of Exercise Science and Physiotherapy, 2, 87–91.

Russell, T. G., Buttrum, P., Wootton, R., & Jull, G. A. (2011). Internet-Based Outpatient Telerehabilitation for Patients Following Total Knee Arthroplasty. The Journal of Bone and Joint Surgery-American Volume, 93(2), 113–120. https://doi.org/10.2106/JBJS.I.01375

Tuckson, R. V., Edmunds, M., & Hodgkins, M. L. (2017).

Telehealth. New England Journal of Medicine, 377(16), 1585–1592. https://doi.org/10.1056/NEJMsr1503323

Zhong, Z., Liu, B., Liu, G., Chen, J., Li, Y., Chen, J., Liu, X., & Hu, Y. (2019). A Randomized Controlled Trial on the Effects of Low-Dose Extracorporeal Shockwave Therapy in Patients With Knee Osteoarthritis. Archives of Physical Medicine and Rehabilitation, 100(9), 1695–1702. https://doi.org/10.1016/j.apmr.2019.04.020