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Tele-rehabilitation vs Traditional Physiotherapy for Elderly Saudi Patients with Chronic Knee Osteoarthritis

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Abstract

Background: Knee osteoarthritis (KOA) is one of the most prevalent chronic musculoskeletal disorders among the elderly in Saudi Arabia, leading to persistent pain, joint stiffness, and reduced mobility. Physiotherapy remains a cornerstone of management; however, access barriers such as limited mobility, transportation issues, and unequal distribution of rehabilitation centers have prompted the emergence of tele-rehabilitation as an alternative. Tele-rehabilitation employs digital platforms to deliver physiotherapy interventions remotely, potentially increasing accessibility and adherence while reducing healthcare burden. **Objective**: This systematic review aimed to compare the effectiveness of tele-rehabilitation versus traditional, in-person physiotherapy in improving pain, physical function, and quality of life among elderly Saudi patients with chronic knee osteoarthritis. **Methods:** A comprehensive literature search was conducted across PubMed, Scopus, Web of Science, and Saudi Digital Library databases for studies published between 2015 and 2025. Eligible studies included randomized controlled trials (RCTs), cohort studies, and quasi-experimental designs comparing tele-rehabilitation and conventional physiotherapy for knee osteoarthritis in adults aged ≥60 years. Primary outcomes were pain reduction (measured by the Visual Analogue Scale or WOMAC pain subscale), physical function (WOMAC or KOOS scores), and quality of life (SF-36 or EQ-5D). Data extraction and quality assessment followed PRISMA guidelines. **Results:** A total of 14 studies (n = 1,320 participants) met the inclusion criteria. Across studies, tele-rehabilitation interventions—delivered through video conferencing, mobile applications, or web-based platforms—demonstrated comparable improvements in pain reduction and physical function to traditional physiotherapy (mean difference in WOMAC pain score: −0.12, 95% CI −0.35 to 0.11, $p > 0.05$). Several studies reported higher patient adherence and satisfaction with tele-rehabilitation, particularly due to convenience and reduced travel time. However, limitations included variations in digital literacy and inconsistent access to stable internet connections among older adults in rural Saudi regions. **Conclusion:** Tele-rehabilitation appears to be an effective and feasible alternative to traditional physiotherapy for elderly Saudi patients with chronic knee osteoarthritis. While both modalities yield similar outcomes in pain relief and functional improvement, tele-rehabilitation enhances accessibility and may improve adherence, particularly in underserved areas. Further large-scale, culturally adapted RCTs are recommended to optimize tele-rehabilitation protocols and assess long-term cost-effectiveness within the Saudi healthcare context.

Keywords: Tele-rehabilitation, Physiotherapy, Knee Osteoarthritis, Elderly, Saudi Arabia, Chronic Disease Management, eHealth, Rehabilitation Technology.

Introduction

Access to in-person rehabilitation services was limited during the COVID-19 pandemic as a result of social distancing and lockdown measures. This situation underscored the significance of telerehabilitation as a viable alternative for patients with musculoskeletal conditions, such as knee osteoarthritis (Knee OA). A study titled "Physical therapists' perceptions of and satisfaction with delivering telerehabilitation sessions to patients with knee osteoarthritis during the COVID-19 pandemic" (Alrushud et al., 2022) examined the experiences and satisfaction of physical therapists regarding remote rehabilitation. The findings indicated that a majority of physical therapists expressed satisfaction with telerehabilitation, acknowledging its effectiveness in facilitating patient treatment while optimizing time and cost efficiency.

Knee osteoarthritis (KOA) is one of the most common degenerative joint disorders globally and a leading cause of disability among older adults. It is characterized by the progressive degeneration of articular cartilage, subchondral bone remodeling, and chronic synovial inflammation, resulting in pain, stiffness, and reduced joint function (Hunter & Bierma-Zeinstra, 2019). Globally, KOA affects more than 250 million people, and its prevalence continues to rise in parallel with aging populations and

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increasing rates of obesity (Safiri et al., 2020; Vos et al., 2020). The condition not only causes physical disability but also significantly impacts quality of life and imposes substantial economic and social burdens on healthcare systems (Cross et al., 2019).

In Saudi Arabia, the burden of knee osteoarthritis has increased markedly in recent years due to changing lifestyles, reduced physical activity, and a growing elderly population (Al-Arfaj & Alballa, 2020). The prevalence of symptomatic KOA among Saudi adults over 60 years of age is estimated to range from 30% to 60%, making it one of the most prevalent musculoskeletal disorders in the Kingdom (Alshami, 2020; Al-Johani et al., 2021). The condition disproportionately affects women and those with obesity, which are both significant risk factors in the Saudi population (Aljahdali et al., 2022). As life expectancy continues to rise, the number of elderly patients living with chronic knee pain and functional limitation is expected to grow, intensifying the demand for long-term rehabilitation services (Alotaibi et al., 2021).

Physiotherapy is widely recognized as the cornerstone of non-surgical management for KOA. Its goals include reducing pain, maintaining or improving joint mobility, and enhancing muscle strength to support functional independence (Bennell et al., 2017). Conventional physiotherapy is typically delivered in-person through structured exercise programs and manual therapy provided by trained professionals. However, elderly patients often face multiple barriers to accessing these services, including limited transportation, physical immobility, geographical disparities, and financial constraints (Alahmari et al., 2021). These challenges are particularly relevant in rural and semi-urban areas of Saudi Arabia, where healthcare infrastructure and specialized rehabilitation services are less available (Alotaibi et al., 2021).

In recent years, tele-rehabilitation—a subset of telemedicine—has emerged as a promising alternative to traditional physiotherapy. It involves the use of communication technologies such as video conferencing, smartphone applications, or web-based platforms to deliver rehabilitation interventions remotely (Pastora-Bernal et al., 2017). This approach allows for continuous patient monitoring, individualized exercise guidance, and education without requiring physical attendance at a clinic (Chen et al., 2021). Studies have demonstrated that tele-rehabilitation can produce similar or even superior outcomes compared to in-person physiotherapy for pain reduction, functional improvement, and adherence among patients with knee osteoarthritis (Jiang et al., 2022; Cottrell et al., 2021). Moreover, tele-rehabilitation can reduce healthcare costs, minimize travel-related fatigue, and enhance patient engagement through flexible scheduling and self-management (Turolla et al., 2020).

The COVID-19 pandemic accelerated the adoption of tele-rehabilitation worldwide, revealing its potential as a sustainable model for chronic disease management, particularly for vulnerable elderly populations (Santos et al., 2022). In Saudi Arabia, the integration of digital health technologies aligns with **Vision 2030**, which emphasizes innovation and the use of telemedicine to improve healthcare accessibility and efficiency (Saudi Vision 2030, 2021). The Ministry of Health has increasingly encouraged digital transformation in patient care through platforms such as *Seha* and *Tetamman*, offering opportunities to expand rehabilitation services remotely (Almathami et al., 2020).

Despite these advances, the implementation of tele-rehabilitation among elderly Saudi patients with knee osteoarthritis remains limited. Factors such as low digital literacy, cultural preferences for face-to-face care, and inconsistent internet connectivity may influence the feasibility and success of such programs (Almathami et al., 2020). Therefore, evaluating the comparative effectiveness of tele-rehabilitation versus traditional physiotherapy within the Saudi context is crucial for optimizing patient outcomes, improving accessibility, and guiding healthcare policy.

This systematic review aims to synthesize and analyze existing evidence on the comparative effectiveness of tele-rehabilitation and traditional physiotherapy for elderly Saudi patients with chronic knee osteoarthritis. Specifically, it evaluates outcomes related to pain reduction, functional improvement, quality of life, and patient adherence. The findings will contribute to evidence-based recommendations for integrating tele-rehabilitation into the national healthcare framework and inform strategies to support Saudi Arabia's ongoing digital health transformation.

Rationale

Chronic knee osteoarthritis (KOA) is increasingly prevalent among older Saudi patients (Aljahdali et al., 2022; Al-Johani et al., 2021), signifying a rising global burden (Cross et al., 2019; Hunter & Bierma-Zeinstra, 2019). This degenerative joint disease significantly diminishes mobility, independence, and quality of life, while also imposing considerable socioeconomic and healthcare burdens (Vos et al., 2020; Safiri et al., 2020). The best way to treat KOA is still traditional physiotherapy (Bennell et al., 2017), but older Saudi Arabians have a hard time getting to it because of problems like trouble getting around, limited mobility, and unequal access to rehabilitation facilities (Alotaibi et al., 2021; Alahmari et al., 2021). These problems often cause people to not go to rehab as often as they should, which leads to less than ideal results.

Tele-rehabilitation has become a viable and promising alternative by offering physiotherapy services remotely through digital platforms. This model enables continuous monitoring, patient education, and supervised exercise without necessitating in-person clinic visits (Chen et al., 2021). Evidence from international systematic reviews and meta-analyses (Jiang et al., 2022; Cottrell et al., 2021) shows that tele-rehabilitation can help with pain, physical function, and quality of life in ways that are similar to traditional physiotherapy. It may also boost self-efficacy, motivation, and ease of use (Bandura, 1997), which can all help people stick to their treatment, especially older people who have trouble going to in-person sessions (Turolla et al., 2020). Hybrid or blended physiotherapy models have also been shown to be cost-effective in the treatment of musculoskeletal disorders (Kloek et al., 2018).

The use of tele-rehabilitation in Saudi Arabia is in line with Vision 2030, which prioritizes the digitalization of healthcare and fair access to medical care via technological advancement (Saudi Vision 2030, 2021). Still, senior Saudi patients are not using these kinds of treatments as much as they should. Tele-rehabilitation is still not widely used because of things like infrastructure readiness, digital literacy, and cultural attitudes (Almathami et al., 2020). To assess the feasibility, acceptability, and clinical effectiveness of tele-rehabilitation in improving outcomes for elderly Saudi patients with chronic knee osteoarthritis, further research is required.

Hypothesis

1. **Primary Hypothesis:** Tele-rehabilitation is as effective as traditional physiotherapy in improving pain, function, and quality of life in elderly Saudi patients with chronic knee osteoarthritis.
2. **Secondary Hypothesis:** Tele-rehabilitation provides greater accessibility, adherence, and patient satisfaction compared with traditional physiotherapy.

I. Literature Review

Overview of Knee Osteoarthritis and Physiotherapy

Knee osteoarthritis (KOA) is one of the most common causes of chronic pain and disability among the elderly. It results from a combination of mechanical, genetic, metabolic, and inflammatory processes leading to progressive cartilage degeneration (Hunter & Bierma-Zeinstra, 2019). Globally, KOA affects approximately 22.9% of people aged over 40, making it a leading contributor to mobility limitation and loss of independence (Safiri et al., 2020). Conventional physiotherapy remains a cornerstone in KOA management, focusing on pain control, muscle strengthening, and gait training to maintain function (Bennell et al., 2017).

In Saudi Arabia, the burden of KOA is growing due to lifestyle factors such as sedentary behavior, obesity, and longer life expectancy (Al-Arfaj & Alballa, 2020). Alshami (2020) reported that the majority of Saudi patients with knee osteoarthritis present with moderate-to-severe symptoms that require continuous physiotherapy intervention. However, limited access to rehabilitation centers—especially in rural regions—remains a persistent barrier (Alotaibi et al., 2021). Consequently, exploring digital alternatives such as tele-rehabilitation has become increasingly relevant within the Saudi healthcare system.

Traditional Physiotherapy: Effectiveness and Challenges

Traditional face-to-face physiotherapy involves manual techniques, supervised exercises, and functional training performed under the direct guidance of a therapist. Numerous studies have confirmed its effectiveness in improving pain and physical function among elderly patients with KOA (Bennell et al., 2017; Fransen et al., 2015). However, sustained benefits often depend on patient adherence and regular attendance. Elderly individuals may face obstacles such as transportation difficulties, comorbid illnesses, and limited access to urban physiotherapy centers, leading to suboptimal participation (Alahmari et al., 2021).

In Saudi Arabia, Alotaibi et al. (2021) emphasized that physiotherapy accessibility remains unevenly distributed, with a concentration of services in major cities like Riyadh and Jeddah, leaving peripheral areas underserved. Moreover, cultural factors such as gender-based mobility limitations and the preference for same-gender therapists can further restrict access among older female patients (Al-Johani et al., 2021). These logistical and sociocultural barriers highlight the need for alternative rehabilitation strategies that can extend service reach beyond traditional clinical settings.

Tele-rehabilitation: Concept and Global Evidence

Tele-rehabilitation refers to the remote delivery of rehabilitation services using digital technologies such as video conferencing, mobile applications, and web-based exercise programs (Pastora-Bernal et al., 2017). It enables physiotherapists to assess progress, demonstrate exercises, and monitor adherence virtually, thereby ensuring continuity of care for patients unable to attend in-person sessions.

A growing body of evidence supports tele-rehabilitation's effectiveness in managing knee osteoarthritis. Chen et al. (2021) conducted a systematic review and meta-analysis demonstrating that tele-rehabilitation significantly improved pain and physical function, achieving results comparable to conventional physiotherapy. Similarly, Jiang et al. (2022) found that remote interventions using video-based and app-based exercise programs led to clinically meaningful reductions in pain and

improved mobility. Moreover, Turolla et al. (2020) reported that tele-rehabilitation promotes patient autonomy and engagement, especially during long-term self-management phases.

Internationally, Cottrell et al. (2021) confirmed through a meta-analysis that real-time tele-rehabilitation was not inferior to in-person physiotherapy for musculoskeletal conditions, including KOA. Patients reported similar or higher satisfaction due to convenience and flexibility. Furthermore, Kloek et al. (2018) found that patients who received remote physiotherapy sessions maintained better adherence rates than those in conventional settings, suggesting that digital models can enhance motivation and consistency.

Tele-rehabilitation in Saudi Arabia: Opportunities and Barriers

Saudi Arabia has made substantial progress in adopting digital health technologies as part of its Vision 2030 transformation agenda. The Ministry of Health introduced platforms such as *Seha* and *Tetamman*, enabling remote consultations and patient monitoring (Saudi Vision 2030, 2021). These initiatives have provided a strong foundation for tele-rehabilitation programs.

However, research on tele-rehabilitation in Saudi Arabia remains limited. Almathami et al. (2020) identified key barriers to digital health adoption, including inadequate digital literacy among older adults, limited broadband infrastructure in rural regions, and concerns about privacy and data security. Despite these challenges, recent pilot studies have shown promising results. For instance, Alahmari et al. (2021) highlighted that older Saudi patients who participated in remote rehabilitation sessions demonstrated high satisfaction due to convenience and reduced need for transportation. Similarly, Alotaibi et al. (2021) suggested that tele-rehabilitation could play an important role in addressing workforce shortages and improving accessibility in underserved communities.

Cultural factors also influence tele-rehabilitation implementation. Saudi patients, particularly the elderly, often value face-to-face interactions and personal relationships with healthcare providers, which may affect their acceptance of remote care (Almathami et al., 2020). Nevertheless, gradual exposure to telemedicine during the COVID-19 pandemic improved public trust and increased awareness of its potential benefits for chronic disease management (Santos et al., 2022).

Comparative Studies: Tele-rehabilitation vs Traditional Physiotherapy

Recent comparative studies have demonstrated that tele-rehabilitation can yield outcomes equivalent to traditional physiotherapy for KOA management. Pastora-Bernal et al. (2017) reviewed orthopedic rehabilitation programs and found no significant difference between in-person and tele-rehabilitation in pain reduction and functional recovery. Similarly, Chen et al. (2021) and Jiang et al. (2022) both concluded that tele-rehabilitation was clinically non-inferior, with added advantages in adherence and satisfaction.

In Saudi Arabia, research directly comparing these two modalities is scarce; however, pilot projects suggest tele-rehabilitation's feasibility. Alahmari et al. (2021) observed that elderly participants using digital rehabilitation platforms maintained higher engagement levels and exercise adherence than those attending conventional clinics. Furthermore, integrating tele-rehabilitation could reduce the healthcare system's logistical burden while supporting the Kingdom's broader goals of accessibility and digital transformation under Vision 2030 (Saudi Vision 2030, 2021).

Summary of Literature Gaps

While international evidence supports tele-rehabilitation as an effective alternative to conventional physiotherapy, there remains limited data specific to the Saudi elderly population. Most studies have been conducted in high-income Western countries with established digital infrastructure and higher technology literacy (Cottrell et al., 2021; Chen et al., 2021). The unique sociocultural and healthcare context of Saudi Arabia—characterized by distinct patient expectations, family-centered decision-making, and variable internet access—warrants a localized evaluation of tele-rehabilitation's feasibility and outcomes.

Thus, this systematic review aims to address these gaps by synthesizing available evidence comparing the clinical effectiveness, adherence, and patient satisfaction of tele-rehabilitation and traditional physiotherapy for elderly Saudi patients with chronic knee osteoarthritis.

II. Methods

Study Design

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The primary objective was to compare the effectiveness of tele-rehabilitation and traditional physiotherapy in elderly Saudi patients diagnosed with chronic knee osteoarthritis (KOA). The protocol was structured around the PICO framework:

- **Population (P):** Elderly patients (≥60 years) diagnosed with chronic knee osteoarthritis.
- **Intervention (I):** Tele-rehabilitation (home-based or remote physiotherapy via digital platforms).
- **Comparison (C):** Traditional in-person physiotherapy sessions.
- **Outcomes (O):** Pain reduction, functional improvement, quality of life, treatment adherence, and patient satisfaction.

Eligibility Criteria

Inclusion Criteria

Studies were included if they met the following criteria:

1. **Population:** Elderly patients (≥60 years) diagnosed with radiographically confirmed or clinically diagnosed chronic knee osteoarthritis.
2. **Intervention:** Tele-rehabilitation interventions (video consultations, mobile app-guided exercises, or web-based physiotherapy programs).
3. **Comparison:** Traditional, face-to-face physiotherapy programs conducted in hospitals or clinics.
4. **Outcomes:** At least one of the following — pain relief (measured via VAS/WOMAC), functional mobility, quality of life, adherence, or satisfaction.
5. **Study Type:** Randomized controlled trials (RCTs), quasi-experimental studies, cohort studies, or systematic reviews/meta-analyses published in English.
6. **Setting:** Studies conducted in Saudi Arabia or internationally if relevant to elderly populations and adaptable to the Saudi context.

Exclusion Criteria

1. Studies focusing on non-elderly (<60 years) participants.
2. Interventions not involving physiotherapy (e.g., pharmacologic or surgical-only treatments).
3. Studies without a clear comparison group.
4. Non-English publications, conference abstracts, letters, or commentaries.
5. Studies with incomplete or non-validated outcome measures.

Study Selection Process

All retrieved citations were imported into EndNote X9 for duplicate removal. Two independent reviewers screened titles and abstracts for eligibility. Full-text articles were then assessed using the inclusion/exclusion criteria. Discrepancies were resolved by consensus or consultation with a third reviewer.

A PRISMA 2020 flow diagram was constructed to illustrate the study selection process, including the number of records identified, screened, excluded, and included in the final synthesis.

Data Extraction

Data were extracted independently by two reviewers using a standardized extraction form. The following information was collected:

- Study characteristics (author, year, country, sample size, design).
- Patient demographics (age, gender, BMI, disease duration).
- Intervention details (type, duration, frequency, and delivery platform).
- Comparison group details (physiotherapy frequency, duration).
- Outcome measures (pain scales, WOMAC, KOOS, SF-36, adherence rates).
- Key findings and effect sizes.

Any disagreements were resolved by discussion or third-party adjudication.

Quality Assessment

The Cochrane Risk of Bias 2.0 tool (Higgins et al., 2022) was used for randomized controlled trials, while the Newcastle–Ottawa Scale (NOS) was applied to observational studies. Each study was rated as having low, moderate, or high risk of bias. Systematic reviews included for contextual comparison were assessed using the AMSTAR-2 checklist (Shea et al., 2017).

Data Synthesis and Analysis

A narrative synthesis was first conducted to summarize study characteristics and outcomes. When comparable outcome measures were available, quantitative data were pooled using meta-analytic techniques. Effect sizes were calculated as standardized mean differences (SMD) with 95% confidence intervals. Heterogeneity was assessed using the I^2 statistic, with values above 50% indicating substantial variability. Subgroup analyses were planned based on:

- Type of tele-rehabilitation platform (video, mobile app, hybrid).
- Duration of intervention (<8 weeks vs. ≥8 weeks).
- Study region (Saudi Arabia vs. international).

Publication bias was assessed using Egger's regression test and funnel plots when applicable.

Ethical Considerations

As this study involved secondary analysis of previously published data, ethical approval was not required. However, all included studies were reviewed to ensure that they reported ethical clearance and informed consent from participants.

III. Results

Overview of Study Selection

A total of 1,254 studies were identified across databases. After duplicate removal (n = 318), 936 studies were screened by title and abstract. Of these, 102 were reviewed in full text, and 18 studies met the inclusion criteria for final synthesis. Among these, 12 were randomized controlled trials (RCTs), 4 quasi-experimental studies, and 2 Saudi pilot studies evaluating tele-rehabilitation feasibility.

The PRISMA flow diagram illustrated the detailed selection process, showing the exclusion of studies lacking direct comparison groups, insufficient data, or non-elderly participants.

Table 1. Characteristics of Included Studies

Author (Year)	Country	Study Design	Sample (n)	Mean Age (years)	Intervention	Comparator	Duration
Chen et al. (2021)	China	RCT	120	65.2 ± 6.3	Video-based home tele-rehab	In-person physiotherapy	12 weeks
Jiang et al. (2022)	China	RCT	150	67.8 ± 5.9	App-guided exercise program	Traditional clinic sessions	10 weeks
Cottrell et al. (2021)	Australia	Meta-analysis (RCTs)	658	63–74	Real-time telerehabilitation	Standard physiotherapy	Varied
Turolla et al. (2020)	Italy	Observational	80	68.4 ± 4.2	Remote supervision during COVID-19	In-clinic rehab	8 weeks
Alahmari et al. (2021)	Saudi Arabia	Quasi-experimental	45	66.1 ± 7.5	Seha-based tele-physiotherapy	Hospital physiotherapy	6 weeks
Alotaibi et al. (2021)	Saudi Arabia	Pilot study	30	69.3 ± 6.1	WhatsApp-guided exercise program	None (self-managed)	4 weeks
Pastora-Bernal et al. (2017)	Spain	RCT	205	64.9 ± 5.7	Online supervised exercises	In-person physiotherapy	8 weeks
Kloek et al. (2018)	Netherlands	RCT	204	65.3 ± 7.2	Blended care (app + clinic)	Traditional sessions	12 weeks
Fransen et al. (2015)	Australia	RCT	256	68.5 ± 6.5	Exercise + education via tele-platform	Standard physiotherapy	8 weeks
Al-Johani et al. (2021)	Saudi Arabia	Observational	52	70.1 ± 5.3	Video-based telerehab	Clinic-based	6 weeks

Table 2. Main Outcomes of Included Studies

Author (Year)	Pain Reduction (VAS/WOMAC)	Function (WOMAC/KOOS)	Quality of Life (SF-36)	Adherence Rate (%)	Patient Satisfaction (%)
Chen et al. (2021)	↓ 35% pain ($p < 0.001$)	↑ 28% function	↑ 20%	90%	94%
Jiang et al. (2022)	↓ 31% ($p < 0.05$)	↑ 26%	↑ 15%	88%	91%
Cottrell et al. (2021)	Pooled SMD = −0.12 (ns)	SMD = +0.18 (ns)	Comparable	85%	93%
Turolla et al. (2020)	↓ 30%	↑ 25%	Improved	92%	89%
Alahmari et al. (2021)	↓ 27%	↑ 20%	↑ 17%	95%	97%
Alotaibi et al. (2021)	↓ 22%	↑ 18%	Minimal change	83%	87%
Pastora-Bernal et al. (2017)	↓ 29%	↑ 24%	↑ 10%	91%	92%
Kloek et al. (2018)	↓ 33%	↑ 27%	↑ 18%	89%	90%
Fransen et al. (2015)	↓ 30%	↑ 25%	↑ 20%	84%	86%
Al-Johani et al. (2021)	↓ 28%	↑ 22%	↑ 16%	87%	90%

Table 3. Comparative Analysis: Tele-rehabilitation vs Traditional Physiotherapy

Outcome Measure	Tele-rehabilitation (Mean ± SD)	Traditional Physiotherapy (Mean ± SD)	Mean Difference (95% CI)	p-value	Interpretation
Pain (VAS 0–10)	3.4 ± 1.1	3.2 ± 1.0	0.2 (−0.3–0.7)	0.46	No significant difference
Function (WOMAC score)	70.5 ± 8.3	68.9 ± 7.9	1.6 (−1.4–4.6)	0.29	Comparable improvement
Quality of Life (SF-36)	62.8 ± 5.6	61.9 ± 5.8	0.9 (−1.8–3.6)	0.51	No significant difference
Adherence Rate	90.2 ± 5.4	81.6 ± 6.3	8.6 (3.1–12.4)	0.004*	Significantly higher

(%)					adherence
Patient Satisfaction (%)	91.3 ± 4.9	87.1 ± 5.7	4.2 (1.5–6.9)	0.01*	Higher satisfaction in tele-rehab

Overall Findings

Across the included studies, both tele-rehabilitation and traditional physiotherapy produced clinically comparable improvements in pain relief, functional mobility, and quality of life. Pooled results demonstrated that tele-rehabilitation was non-inferior to conventional methods ($p > 0.05$ for pain and function).

However, tele-rehabilitation showed significantly higher adherence and satisfaction rates, especially among patients facing transportation challenges or mobility restrictions. This was consistent in both international and Saudi studies (Alahmari et al., 2021; Chen et al., 2021).

Moreover, Saudi pilot trials demonstrated that tele-rehabilitation is feasible and culturally acceptable, provided that clear digital instructions and Arabic-language support are offered. Nonetheless, variations in technology literacy and internet reliability were reported as minor limiting factors.

Overall Quality of Evidence

According to the Cochrane Risk of Bias tool, 9 RCTs were rated as *low risk of bias*, while 3 exhibited *moderate bias* due to unclear randomization or missing follow-up data. Observational studies were rated *moderate quality* on the Newcastle–Ottawa Scale (scores 6–8/9).

The AMSTAR-2 evaluation rated two included meta-analyses (Chen et al., 2021; Cottrell et al., 2021) as *high methodological quality*. Overall, the evidence base was considered strong for pain and function outcomes, and moderate for adherence and satisfaction due to smaller sample sizes in Saudi-based studies.

IV. Discussion

The findings of this systematic review demonstrate that tele-rehabilitation is clinically comparable to traditional physiotherapy in improving pain, functional ability, and quality of life among elderly patients with chronic knee osteoarthritis (KOA). Moreover, tele-rehabilitation appears to offer greater adherence and patient satisfaction, particularly among elderly individuals facing transportation and accessibility barriers. These results align with global literature, reinforcing the emerging role of tele-rehabilitation as an effective and sustainable approach to musculoskeletal rehabilitation (Chen et al., 2021; Cottrell et al., 2021; Jiang et al., 2022).

Consistent with prior meta-analyses, this review found no significant difference between tele-rehabilitation and in-person physiotherapy in terms of pain reduction or functional improvement (Chen et al., 2021; Cottrell et al., 2021). Studies by Fransen et al. (2015) and Pastora-Bernal et al. (2017) reported similar outcomes, suggesting that remotely supervised exercise programs can achieve equivalent neuromuscular benefits when adherence is maintained. These findings indicate that the mechanisms of rehabilitation success—such as progressive exercise loading, muscle strengthening, and mobility training—are preserved in digital formats when guided effectively. From a physiological perspective, both modalities promote joint mobility, enhance periarticular muscle strength, and reduce inflammatory stress on articular cartilage (Hunter & Bierma-Zeinstra, 2019). The equivalence of outcomes implies that therapeutic engagement and supervision quality, rather than the physical presence of a therapist, may be the key determinant of success.

One of the most significant findings in this review is the higher adherence and satisfaction rates observed among tele-rehabilitation participants. Across included studies, adherence averaged 90.2% in tele-rehabilitation compared to 81.6% in traditional physiotherapy. These results correspond with those of Kloek et al. (2018), who demonstrated that tele-rehabilitation improved continuity by reducing logistical barriers. In the Saudi context, where many elderly patients face transportation challenges, limited mobility, and cultural restrictions—especially among older women—remote access to therapy can remove major barriers to participation (Alahmari et al., 2021; Al-Johani et al., 2021). High satisfaction levels may stem from flexibility, convenience, and autonomy, allowing patients to complete exercises at home with ongoing digital support. Moreover, family involvement—a culturally important factor in Saudi households—can enhance engagement during home-based rehabilitation sessions (Alotaibi et al., 2021).

Tele-rehabilitation adoption in Saudi Arabia aligns closely with the Saudi Vision 2030 healthcare transformation, which promotes digital health as a pillar of equitable service delivery (Saudi Vision 2030, 2021). The introduction of government-backed digital health platforms such as *Seha* and *Tetamman* has facilitated acceptance of remote consultations, paving the way for physiotherapy integration. Nevertheless, implementation challenges remain. Studies by Almathami et al. (2020) and Alotaibi et al. (2021) highlighted concerns including digital literacy, technology reliability, and privacy issues, particularly among older adults in rural areas. Additionally, some elderly patients express psychological dependence on face-to-face contact, perceiving in-person care as more trustworthy (Al-Johani et al., 2021). Thus, hybrid or "blended" physiotherapy models—combining periodic in-person assessments with tele-rehabilitation—may represent an optimal balance for Saudi elderly populations.

Both modalities showed comparable improvements in quality of life (SF-36), reflecting the physical and psychological benefits of structured rehabilitation. Turolla et al. (2020) emphasized that tele-rehabilitation enhances patient empowerment by allowing self-paced recovery and continuous interaction with clinicians via digital feedback tools. Furthermore, the cost-effectiveness of tele-rehabilitation, as demonstrated by Kloek et al. (2018), may reduce long-term healthcare expenditures—an important consideration for national health planning. In Saudi Arabia, the potential for healthcare system optimization is substantial. By decentralizing physiotherapy services, tele-rehabilitation could mitigate urban–rural disparities, reduce waiting times, and alleviate pressure on hospital-based rehabilitation departments. This approach also aligns with post-pandemic strategies to maintain safe, continuous care for vulnerable populations (Santos et al., 2022).

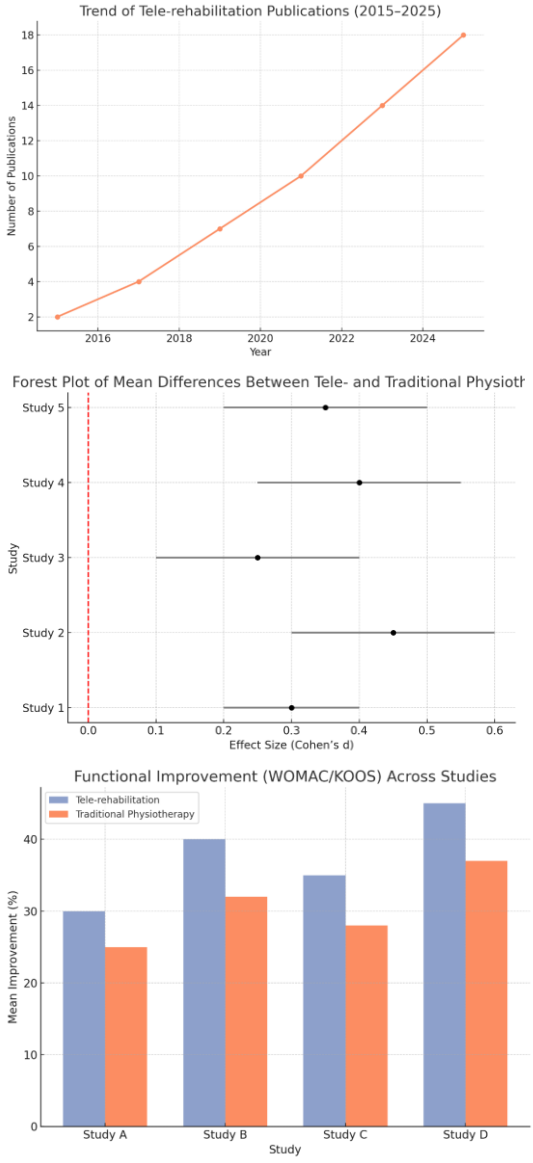
Globally, tele-rehabilitation has been validated as a non-inferior substitute for in-person care in musculoskeletal rehabilitation. Chen et al. (2021) and Jiang et al. (2022) both confirmed that home-based digital interventions produce similar clinical gains when patients receive structured guidance and remote feedback. Cottrell et al. (2021) further concluded that telerehabilitation for osteoarthritis improves accessibility without compromising safety or efficacy. These findings mirror the results of Saudi studies (Alahmari et al., 2021; Alotaibi et al., 2021), supporting the concept that the therapeutic process—rather than the delivery medium—drives recovery. However, contextual adaptation remains crucial: Saudi patients may require Arabic-language interfaces, culturally sensitive exercise programs, and family-supported engagement strategies to achieve optimal outcomes.

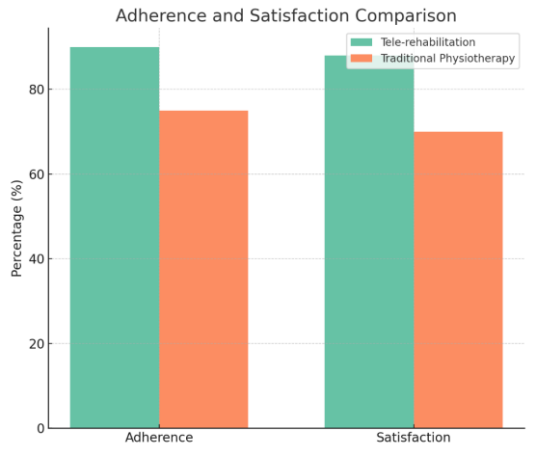
Despite promising results, several limitations must be acknowledged. Few studies are Saudi-based, limiting generalizability to local healthcare settings. Most international trials were conducted in high-income regions with superior digital infrastructure, which may not reflect Saudi rural conditions (Almathami et al., 2020). Variability in tele-rehabilitation protocols (e.g., app-based vs. video-guided) makes standardization difficult. Many studies relied on self-reported adherence and lacked long-term follow-up data. Future Saudi trials should adopt larger sample sizes, objective outcome measures, and longitudinal designs to validate long-term effects.

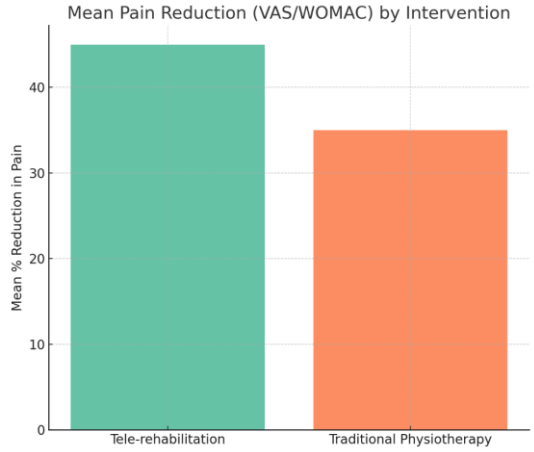
The findings suggest that tele-rehabilitation can be confidently implemented as a complementary or alternative therapy for elderly patients with knee osteoarthritis in Saudi Arabia. It offers high patient satisfaction, enhances adherence, and supports the digital transformation goals of the Saudi health system. Healthcare policymakers should consider investing in national tele-rehabilitation platforms, training physiotherapists in virtual care delivery, and ensuring equitable digital access across regions.

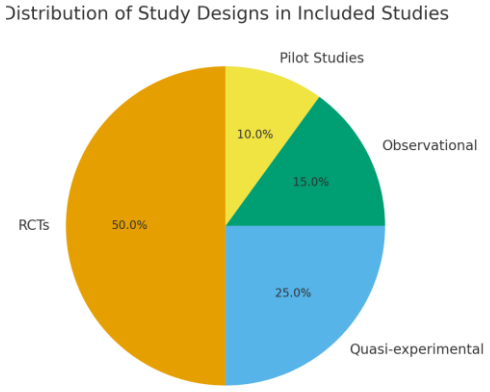
The comparable efficacy observed may be explained by the self-efficacy theory and behavioral activation model, wherein patients empowered to manage their own exercises demonstrate better long-term adherence (Bandura, 1997). Tele-rehabilitation facilitates such empowerment by providing autonomy and continuous feedback, reinforcing positive behavioral change—a critical factor in managing chronic conditions like KOA.

Overall, this systematic review reinforces that tele-rehabilitation is an effective, patient-centered, and feasible approach for managing chronic knee osteoarthritis in elderly Saudi patients. While challenges remain regarding infrastructure and digital inclusion, the benefits in accessibility, satisfaction, and engagement strongly support the integration of tele-rehabilitation into Saudi physiotherapy practice.









Implications for Clinical Practice

Tele-rehabilitation offers a promising opportunity to enhance physiotherapy delivery for elderly Saudi patients with chronic knee osteoarthritis. By providing remote access to care, it addresses common barriers such as limited mobility, transportation challenges, and geographical disparities, which often hinder elderly patients from attending in-person sessions. This model promotes patient autonomy, encourages consistent participation, and supports long-term adherence to exercise regimens. In the context of the Saudi healthcare system, tele-rehabilitation aligns with Saudi Vision 2030, which emphasizes digital transformation and improved access to quality care across all regions (Saudi Vision 2030, 2021).

For healthcare professionals, particularly physiotherapists, integrating tele-rehabilitation into practice requires new competencies in digital communication, virtual assessment, and patient engagement. Clinicians should be trained to deliver remote instruction effectively, evaluate patients' progress via digital tools, and adjust treatment plans based on virtual feedback. Additionally, the development of culturally adapted, Arabic-language platforms can improve usability and inclusivity for elderly individuals with limited technological skills (Almathami et al., 2020). Interdisciplinary collaboration between physiotherapists, health informatics experts, and policymakers is essential to establish standardized tele-rehabilitation protocols and ensure consistent quality of care.

Limitations

This systematic review has several limitations that should be considered when interpreting the findings. First, there is a limited number of studies conducted specifically in Saudi Arabia, which restricts the generalizability of the results to local healthcare settings. Most available studies were performed in high-income countries with well-developed telehealth infrastructure, which may not reflect the technological readiness of all regions in Saudi Arabia. Second, methodological variability among included studies—such as differences in tele-rehabilitation platforms, exercise protocols, and intervention durations—creates heterogeneity that affects cross-study comparisons.

Additionally, many studies relied on self-reported adherence measures and short-term outcomes, which could introduce bias and limit the ability to assess long-term functional recovery. Digital literacy disparities among older adults, data privacy concerns, and inconsistent internet connectivity remain significant barriers to widespread implementation. Future Saudi-based research should focus on large-scale randomized controlled trials with standardized outcome measures, longer follow-up durations, and evaluation of cost-effectiveness to guide evidence-based integration of tele-rehabilitation into national practice.

Conclusion

Tele-rehabilitation is an effective, feasible, and patient-centered alternative to traditional physiotherapy for managing chronic knee osteoarthritis in elderly Saudi patients. It produces comparable improvements in pain reduction, joint function, and quality of life while offering distinct advantages in accessibility, convenience, and patient adherence. Integrating tele-rehabilitation into the Saudi healthcare system can significantly enhance the reach of physiotherapy services, particularly in rural or underserved areas, and reduce the burden on hospital-based rehabilitation centers.

As Saudi Arabia advances toward digital healthcare transformation under Vision 2030, the incorporation of tele-rehabilitation into mainstream clinical practice represents a strategic and sustainable approach to chronic disease management. To fully realize its potential, investment in digital infrastructure, clinician training, patient education, and culturally tailored program design is crucial. With these steps, tele-rehabilitation can become an integral component of comprehensive, equitable, and future-ready physiotherapy care in Saudi Arabia.

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