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Role of Wearable Devices in Monitoring Rehabilitation Outcomes in Physiotherapy Patients

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ABSTRACT

Background: In physiotherapy, keeping track of how patients recover is very important. Usually, therapists rely on clinic visits, short physical tests, or patient feedback. This means small changes in daily activity or function may not always be noticed. Recently, wearable devices have started being used more in rehabilitation. These small gadgets can track movement, activity, and other body signals continuously, even outside the clinic. **Objective:** To explore the role of wearable devices in monitoring rehabilitation outcomes in physiotherapy patients. **Methodology:** We conducted this systematic review according to PRISMA guidelines to evaluate experimental studies using wearable devices to monitor rehabilitation outcomes in physiotherapy patients (2015–2025). Studies included musculoskeletal, neurological, cardiac, and pulmonary patients using devices such as smartwatches, motion sensors, IMUs, and biofeedback tools. Only experimental designs published in English were included, while reviews, case reports, and studies on healthy participants were excluded. Four databases (PubMed, Scopus, Web of Science, Google Scholar) were searched using combined keywords. After screening 1,268 records and removing duplicates, 30 studies met the inclusion criteria. Data on study design, devices, outcomes, and findings were extracted and synthesized qualitatively due to heterogeneity. Independent reviewers ensured unbiased selection, providing a structured evaluation of wearable technology in rehabilitation monitoring. **Results:** A total of thirty studies met the inclusion criteria. Wearable devices were used to track activity levels, walking patterns, joint movements, muscle activity, and other body signals during rehabilitation. Many studies showed that wearable data reflected improvements in function and helped therapists follow patient progress more closely. However, studies differed in design, device types, outcome measures, and rehab programs. **Conclusion:** Wearable devices seem useful for tracking rehabilitation outcomes in physiotherapy. They may help therapists plan treatment better and allow patients to be monitored remotely. Still, more well-designed, larger studies are needed to develop consistent methods and support wider use in clinics.

Keywords: Functional recovery assessment, Physiotherapy rehabilitation, Rehabilitation outcome monitoring, Remote patient monitoring, Wearable devices

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INTRODUCTION

Rehabilitation in physiotherapy is often long and challenging for patients. The goal is to help people regain strength, movement, and normal function after an injury, surgery, or illness. Usually, therapists check progress through clinic visits, short tests, and patient reports. These methods are useful, but don't always show how patients perform during daily activities or at home. Wearable devices are starting to fill this gap. They are small gadgets worn on the body that can track movement, activity, and other signals over time.[1] These devices provide a chance to monitor rehabilitation in a more detailed and objective way. Wearable technology includes smartwatches, motion sensors, inertial measurement units (IMUs), and biofeedback tools. These devices can track steps, joint range, walking patterns, balance, and even muscle activity. Therapists can use this information to see how patients are doing outside of clinic visits.

Early studies suggest that wearable devices may improve monitoring of recovery and help patients stick to therapy plans.[2] Despite these benefits, wearable devices are not yet common in everyday physiotherapy, and questions remain about the best ways to use them. Many experimental studies have tested wearable devices in rehabilitation. For example, after total knee arthroplasty (TKA), motion trackers have been used to monitor recovery. One randomized trial found that patients using wearable trackers with smartphone feedback had better improvements in pain, stiffness, and function compared to patients doing standard exercises alone.[3] These findings suggest that wearable devices may add real value beyond traditional monitoring.

Wearable devices have also been studied in neurological rehabilitation. After a stroke, sensors can help predict walking ability. One study found that data from motion sensors collected at admission helped predict whether patients could walk independently by discharge.[4] This shows that wearable devices may help plan rehabilitation early in recovery. Systematic reviews show that wearable devices are being used in various clinical areas. One review reported that consumer-grade wearables could be used alongside or instead of standard physiotherapy in some non-chronic conditions. These devices were found to be feasible and acceptable in patients.[5] Another review highlighted that wearable sensors can provide continuous and non-invasive tracking of gait, mobility, and functional health.[6]

Collecting data over long periods and in real-world settings gives therapists a better understanding of patient progress than short clinic assessments. Wearable devices may also help in pulmonary and cardiac rehabilitation. In pulmonary rehab programs for people with chronic lung disease, wearables encouraged patients to be more active, although the effects on quality of life were mixed.[7] In cardiac rehab, devices that monitored activity and guided exercise helped patients improve fitness and be more active compared with standard care.[8] These results show that wearables may support different kinds of rehabilitation beyond musculoskeletal recovery.

Gait and balance can also be measured using wearable devices. Reviews show that sensors can detect movement patterns and balance changes that traditional assessments may miss.[9] Wearable gait analysis provides detailed information about walking mechanics and patient mobility. This can help track recovery more accurately than standard clinic tests.[3] Despite these advantages, there are challenges. Studies show differences in device types, how outcomes are measured, and rehabilitation protocols. Wearables also vary in accuracy, battery life, data processing, and ease of use. Costs, data privacy, and acceptance by therapists and patients can be barriers.[10]

Some clinicians are interested in using wearables but want more training and evidence before fully integrating them. Another issue is that most studies are done in controlled settings. Fewer studies look at how wearables work in real home environments over long periods. Understanding real-world use is important to see how wearable devices can truly improve rehabilitation. Standardized guidelines and outcome measures are needed so results can be compared across studies and patients. Technology is improving, making wearables more accurate, affordable, and easier to use. They may become part of routine monitoring in physiotherapy, helping therapists make better treatment decisions and keeping patients motivated.

Current evidence shows a promising role for wearable devices, but more high-quality research is needed before they are widely used in clinics. In summary, wearable devices are becoming important in tracking rehabilitation outcomes.

They provide continuous, objective data that complements traditional assessments. Experimental studies and reviews show benefits in multiple rehabilitation areas, but challenges remain. Addressing these challenges will be key to making the best use of wearable technology in physiotherapy. The main aim of this review is to look at experimental studies that have explored wearable devices in physiotherapy rehabilitation. It focuses on how these devices are applied in practice, what benefits they offer for tracking patient progress, and how effective they are. By summarizing current evidence, this review aims to give clinicians and researchers insights into the practical use of wearable technology and its potential to improve rehabilitation outcomes.

METHODOLOGY

We conducted this study as a systematic review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Our goal was to look at experimental studies that used wearable devices to monitor rehabilitation outcomes in physiotherapy patients. We focused on studies published between 2015 and 2025 to capture the newest ways wearable technology has been applied in rehabilitation. Reviews like this help combine results from different studies so we can get a clearer picture of what works and where more research is needed. To make sure only relevant studies were included, we set clear criteria.

Studies were considered if they involved patients undergoing physiotherapy for musculoskeletal, neurological, cardiac, or pulmonary conditions. They also had to use wearable devices such as smartwatches, motion sensors, IMUs, or biofeedback tools to track rehabilitation outcomes. Only experimental studies were included, such as randomized controlled trials, quasi-experiments, or pilot interventions, and they needed to be published in English between 2015 and 2025. We left out reviews, editorials, abstracts, case reports, studies that did not assess rehabilitation outcomes, and studies that only included healthy participants. This helped ensure that the studies we included were directly relevant to real physiotherapy practice and provided useful information about how wearable devices help monitor recovery.

We carried out a careful search to find all relevant studies. Four databases were searched: PubMed, Scopus, Web of Science, and Google Scholar. We chose these databases because they cover a wide range of healthcare, rehabilitation, and technology research. Keywords included “wearable devices,” “physiotherapy,” “rehabilitation,” “monitoring,” and “rehabilitation outcomes.” We combined these using AND and OR to capture as many relevant studies as possible. After removing duplicates, we screened the remaining records by title and abstract. Then, we read the full texts of studies that seemed relevant. Two reviewers did this independently, and if they disagreed about a study, we discussed it or consulted a third reviewer to make the final decision. For each study that was included, we wrote down the key information using a standard form. This included the author and year, study design, and sample size, the type of wearable device used, and the rehabilitation condition or patient population.

We also noted what outcomes were measured, such as activity levels, gait patterns, joint movements, muscle activity, and physiological responses. Finally, we recorded the main findings to see how wearable devices helped track patient progress. This method helped us keep the data organized and made it easier to compare different studies. Because the studies used different devices and measured different outcomes, we did not combine the results into a meta-analysis. Instead, we looked for patterns and trends. For example, we noted which devices were used most often, what outcomes were tracked, and whether the devices seemed effective in monitoring rehabilitation. We also pointed out where the evidence was weak or missing, which can help guide future research in this area.

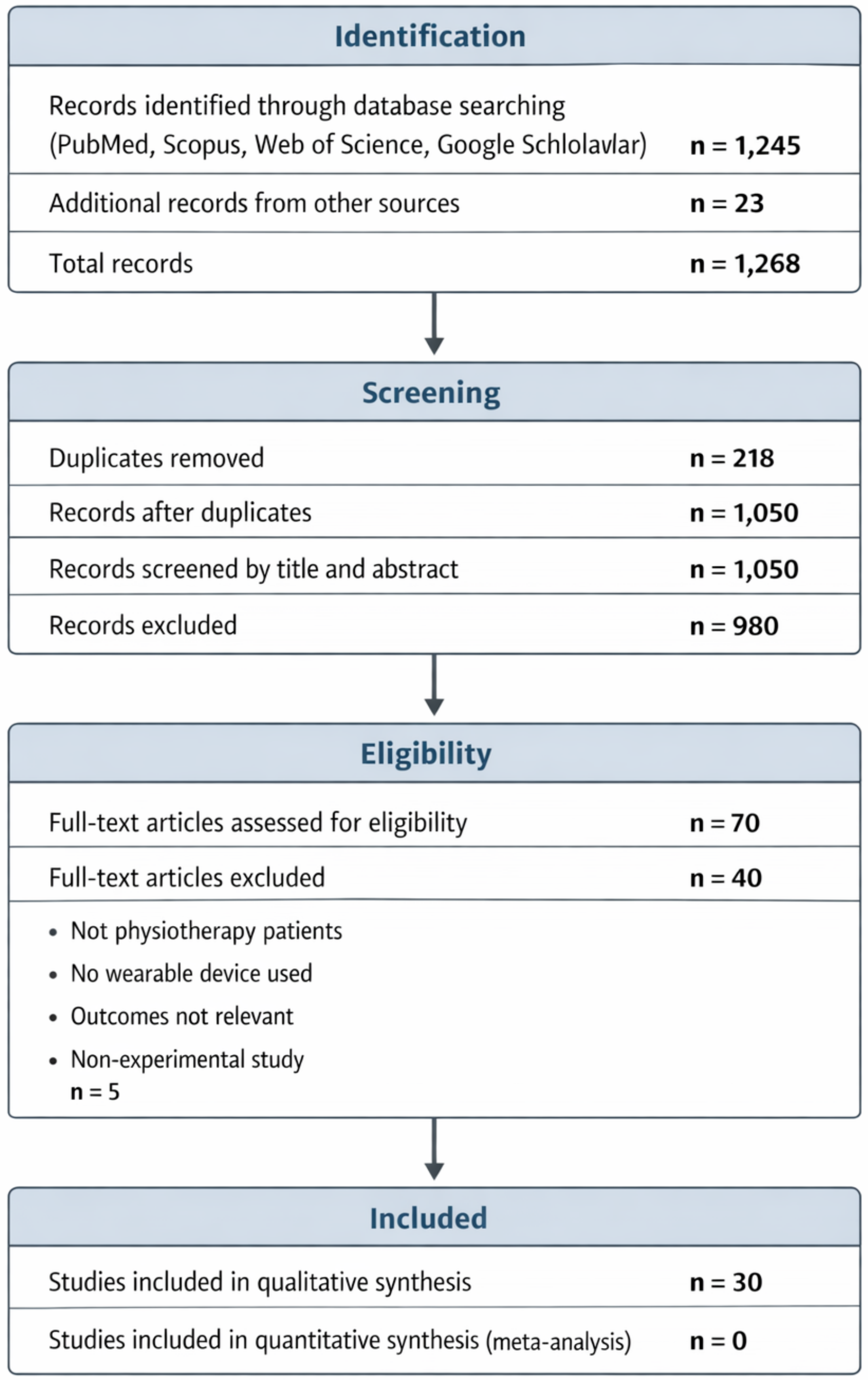
We summarized the study selection process using a PRISMA flow chart. The initial search found 1,245 records, and we found 23 more by checking references, for a total of 1,268 records. After removing 218 duplicates, we looked at 1,050 titles and abstracts and excluded 980. We read the full texts of the remaining 70 articles and excluded 40 for various reasons: not being physiotherapy patients (n=15), not using a wearable device (n=12), outcomes not relevant (n=8), or not being an experimental study (n=5). In the end, 30 studies were included in our review. None of the studies were included in a meta-analysis because the types of devices and outcomes were too different.

To make sure the review was done carefully and reliably, all steps were done independently by at least two reviewers. We met regularly to discuss differences in decisions and make sure the inclusion and exclusion rules were applied fairly. If there was still a disagreement, a senior reviewer helped resolve it. This approach helped reduce bias and made sure the findings of the review were trustworthy. Overall, this methodology gave us a clear and structured way to find, evaluate, and summarize the experimental evidence on wearable devices in physiotherapy rehabilitation. By setting clear inclusion and exclusion criteria, doing a thorough search, extracting data carefully, and synthesizing it qualitatively, we were able to provide meaningful insights into how wearable devices are being used and how effective they are in monitoring patient recovery.

RESULTS

The study selection process was carried out in line with PRISMA recommendations. When we first conducted the database search across PubMed, Scopus, Web of Science, and Google Scholar, a total of 1,245 records were identified. While going through reference lists of relevant papers, we came across 23 additional studies that seemed to fit the scope of this review. This brought the combined total to 1,268 records. The next step involved removing duplicate entries. After careful checking, 218 duplicate records were excluded. Once this was done, 1,050 studies remained and were taken forward for title and abstract screening. At this

Figure 1: PRISMA flow diagram



stage, we reviewed each record to judge its relevance to physiotherapy rehabilitation and wearable monitoring. A large number of studies had to be excluded here, mainly because they did not involve experimental designs, did not include physiotherapy patients, or did not use wearable devices. In total, 980 records were removed during this phase.

Seventy articles moved forward to full-text assessment. Each of these papers was read in detail to confirm eligibility. After closer evaluation, 40 studies were excluded. Fifteen of these did not involve physiotherapy rehabilitation populations, twelve did not actually use wearable monitoring devices, eight did not report rehabilitation-related outcomes, and five were not experimental in design. After completing this screening process, 30 experimental studies fulfilled all inclusion criteria and were included in the qualitative synthesis. Due to the variation in devices, outcomes, and study protocols, a meta-analysis was not conducted. The 30 included studies represented a mix of rehabilitation settings. Many focused on musculoskeletal rehabilitation, particularly post-operative recovery following procedures such as total knee or hip replacement. Others explored neurological rehabilitation, especially stroke recovery and balance training.

A smaller number of studies examined wearable monitoring within cardiac and pulmonary rehabilitation programs. Sample sizes differed noticeably between studies. Some pilot investigations included relatively small participant groups, while randomized controlled trials enrolled larger cohorts. Monitoring periods also varied, ranging from short-term tracking over a few weeks to longer follow-ups extending several months. This variation reflected the exploratory as well as clinical trial nature of the evidence base. A wide range of wearable technologies was used across the included studies. Common devices included smartwatch-based trackers, wearable motion sensors, inertial measurement units, accelerometers, and biofeedback systems. In several trials, wearable devices were paired with smartphone applications to provide real-time feedback or remote monitoring capabilities.

These devices were used to capture multiple rehabilitation outcomes. Frequently monitored parameters included daily physical activity levels, step counts, gait speed, and walking symmetry. Joint range of motion and limb movement patterns were also assessed, particularly in orthopaedic rehabilitation. In neurological settings, balance and postural control were commonly measured. Some studies extended monitoring to muscle activation patterns and physiological indicators such as heart rate during exercise sessions. Overall, most experimental studies suggested that wearable devices were useful in tracking rehabilitation progress. Continuous monitoring allowed therapists to observe patient performance beyond clinic visits, offering a more realistic picture of functional recovery. Several trials reported that patients who used wearable-supported rehabilitation demonstrated better adherence to prescribed exercise programs.

In post-surgical musculoskeletal rehabilitation, wearable monitoring is often aligned with improvements in mobility and functional outcome scores. Neurological studies highlighted the predictive value of sensor-derived gait data in estimating walking recovery. Cardiac and pulmonary rehabilitation trials showed that activity-tracking wearables could encourage greater participation in physical activity programs. At the same time, findings were not entirely consistent across all studies. Differences in study design, device accuracy, monitoring duration, and rehabilitation protocols created variability in reported outcomes. Some studies showed only modest benefits, suggesting that device effectiveness may depend on how and where the technology is applied.

While reviewing the included evidence, several gaps became apparent. Many experimental trials were conducted with small samples, limiting generalizability. Monitoring durations were sometimes short, making it difficult to assess long-term rehabilitation impact. There was also limited standardization in wearable placement, calibration, and outcome reporting methods. Another observation was that most studies were conducted in supervised clinical or semi-controlled environments. Fewer investigations explored long-term home-based monitoring, which is where wearable devices may have the greatest practical value. Addressing these gaps will be important for future research and for wider clinical adoption.

DISCUSSION

In this review, we explored how wearable devices are being used to track rehabilitation outcomes in physiotherapy patients. Reading through the studies, it became clear that wearable technology offers a more continuous and real-world perspective on patient progress compared to traditional episodic assessments. Traditionally, therapists rely on clinic visits, short physical tests, and patient feedback to gauge recovery. While helpful, these methods often miss day-to-day variations in activity and function.

Wearable devices, including smartwatches, motion sensors, and IMUs, allow clinicians to capture patient movement, muscle activity, gait, and physiological responses outside the clinic setting, providing a richer picture of rehabilitation progress.[11] One of the most promising findings across multiple studies is that wearable devices are generally feasible and acceptable to patients. A recent systematic review indicated that consumer-grade devices, such as fitness trackers, could reliably monitor steps, walking distance, and activity patterns, and were well-received by patients undergoing physiotherapy for musculoskeletal conditions.[12] Similarly, another review highlighted that patients using wearable feedback demonstrated improved adherence to prescribed exercises and higher engagement with rehabilitation programs, suggesting wearables may increase motivation.[13]

In orthopaedic rehabilitation, wearables have been widely used following procedures such as TKA. One randomized controlled trial showed that patients using a wearable motion tracker paired with smartphone feedback reported significant improvements in pain, stiffness, and functional scores compared to those following standard physiotherapy exercises alone.[14] Longitudinal monitoring also revealed that wearable-derived gait metrics could detect subtle improvements in walking patterns and identify patients responding better to therapy, offering sensitive and individualized feedback.[15]

Neurological rehabilitation is another area where wearables are proving valuable. Studies on post-stroke patients have used sensors to predict walking ability and monitor gait recovery over time. Motion sensor data collected at admission reliably predicted patients' walking independence at discharge, enabling clinicians to tailor early interventions.[16] Furthermore, real-time biofeedback through wearable devices has been linked to improvements in balance, gait speed, and functional mobility, demonstrating how continuous data can enhance motor learning.[17] Beyond musculoskeletal and neurological settings, wearable devices have been tested in pulmonary and cardiac rehabilitation. In patients with chronic respiratory disease, wearables encouraged increased physical activity, although effects on overall quality of life were mixed.[18] In cardiac rehab, devices that combined monitoring with guided exercise improved cardiorespiratory fitness and activity adherence compared with standard care.[19] These results illustrate that wearables are versatile tools that can support multiple rehabilitation domains.

Many studies had small sample sizes and short follow-up periods, limiting generalizability. Device heterogeneity, differences in placement, and variability in outcome measures also make cross-study comparisons difficult.[20] Measurement accuracy is another concern; while consumer-grade devices are accessible, their estimates of activity may differ from research-grade sensors, emphasizing the importance of choosing appropriate devices for specific outcomes.[21] Integration into clinical practice also requires training, data management infrastructure, and attention to privacy concerns.

Nevertheless, wearable devices provide practical benefits. They allow remote monitoring and support home-based rehabilitation models, which can be especially important when in-person sessions are limited. Feasibility studies show that patients generally comply well with wearable use and perceive the devices positively.[22] Wearables also enable therapists to personalize treatment plans based on objective trends rather than snapshots from occasional clinic visits. Future research should focus on larger randomized trials, standardized protocols, and integration with tele-rehabilitation platforms. Wearable technology has the potential to enhance patient engagement, improve functional outcomes, and make rehabilitation monitoring more objective and continuous. Overall, wearables represent an important tool for physiotherapy, offering valuable data to support clinical decision-making and individualized care.

CONCLUSION

Wearable devices have shown significant potential in monitoring rehabilitation outcomes in physiotherapy. They provide continuous, real-time, and objective data on patient activity, gait, balance, muscle activity, and physiological responses, giving therapists a more detailed understanding of recovery than traditional clinic-based assessments. Evidence suggests that these devices can improve patient engagement, adherence to exercise programs, and individualized care planning. However, challenges remain, including variability in device types, outcome measures, clinical protocols, and data accuracy. Issues such as usability, cost, data privacy, and integration into routine practice must also be addressed to ensure widespread adoption.

Based on the current evidence, several recommendations can be made. Clinicians should integrate wearable devices into routine rehabilitation where feasible, using them to supplement traditional assessments and guide personalized interventions. Standardized guidelines for device selection, placement, and outcome reporting should be developed to allow consistency across studies and clinical practice. Training programs for both clinicians and patients are essential to maximize the usability and interpretation of wearable-derived data. Finally, future research should focus on large-scale, high-quality trials, long-term follow-up, and real-world implementation to optimize wearable technology and confirm its benefits across musculoskeletal, neurological, cardiac, and pulmonary rehabilitation. With these steps, wearable devices can become a valuable tool for improving recovery and functional outcomes in physiotherapy practice.

DECLARATIONS

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AUTHOR CONTRIBUTIONS

SM: Conceived the study design, supervised data collection, and critically reviewed the manuscript.
FM: Drafted the manuscript, including the introduction and methodology sections.
ZA: Prepared results and discussion section, and review of the final manuscript.
All authors had read and approved the final manuscript.

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