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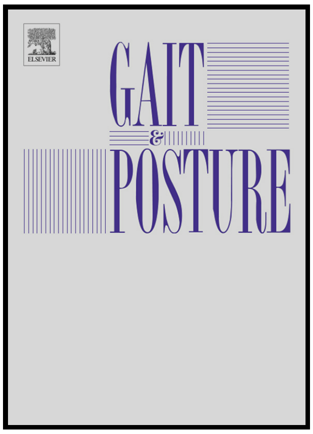


# Factors influencing the clinical adoption of quantitative gait analysis technology with a focus on clinical efficacy and clinician perspectives: A scoping review

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**Title:** Factors influencing the clinical adoption of quantitative gait analysis technology with a focus on clinical efficacy and clinician perspectives: A scoping review.

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**Keywords:** quantitative gait analysis, clinical efficacy, clinician perspectives, technology acceptance

**ABSTRACT**

**Introduction:** Quantitative gait analysis (QGA) has the potential to support clinician decision-making. However, it is not yet widely accepted in practice. Evidence for clinical efficacy (i.e., efficacy and effectiveness), as well as a users' perspective on using the technology in clinical practice (e.g., ease of use and usefulness) can help impact their widespread adoption.

**Objective:** To synthesize the literature on the clinical efficacy and clinician perspectives on the use of gait analysis technologies in the clinical care of adult populations.

**Methods:** This scoping review followed the Joanna Briggs Institute (JBI) methodology for scoping reviews. We included peer-reviewed and gray literature (i.e., conference abstracts). A search was conducted in MEDLINE (Ovid), CENTRAL (Ovid), EMBASE (Ovid), CINAHL (EBSCO) and SPORTDiscus (EBSCO). Included full-text studies were critically appraised using the JBI critical appraisal tools.

**Results:** A total of 15 full-text studies and two conference abstracts were included in this review. Results suggest that QGA technologies can influence decision-making with some evidence to suggest their role in improving patient outcomes. The main barrier to ease of use was a clinician's lack of data expertise, and main facilitator was receiving support from staff. Barriers to usefulness included challenges finding suitable reference data and data accuracy, while facilitators were enhancing patient care and supporting clinical decision-making.

**Significance:** This review is the first step to understanding how QGA technologies can optimize clinical practice. Many gaps in the literature exist and reveal opportunities to improve the clinical adoption of gait analysis technologies. Further research is needed in two main areas: 1) examining the clinical efficacy of gait analysis technologies and 2) gathering clinician perspectives using a theoretical model like the Technology Acceptance Model to guide study design. Results will inform research aimed at evaluating, developing, or implementing these technologies.

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**Key words:** quantitative gait analysis, clinical efficacy, clinician perspective, technology acceptance

## INTRODUCTION

Gait impairments are commonly experienced in people with musculoskeletal, neurological, and cardiovascular diseases and can negatively influence a person's independence, quality of life and participation in society.[1] Thus, conducting gait assessments becomes critical for clinicians to assess patient risk, develop treatment programs, and improve patient outcomes. Gait assessments are commonly performed using observational gait analysis, which involves a clinician's visual observation of a patient's gait.[2,3] In some instances, observational gait analysis may also be accompanied by outcome measures to evaluate gait patterns and measure change with intervention. Examples of these outcome measures include the Gait Assessment and Intervention Tool, Functional Gait Assessment, and the Edinburgh Visual Gait Score.[4] However, even with the use of outcome measures or scales, the reliability of observational gait analysis varies. [5–7] To mitigate this limitation, quantitative gait analysis may be used as an alternative or in combination with observational gait analysis. Quantitative gait analysis provides objective measures of the gait cycle that can be used to assess and monitor change in a patient's gait. In some instances, quantitative gait analysis can also give clinicians information that cannot be gathered via observational gait analysis alone such as kinetic measures (e.g., force and power). Ultimately, this information may better inform clinical decision-making. Quantitative gait analysis makes use of wearable sensors, non-wearable sensors, or a combination of both,[8] and over the last decade, research on these technologies has increased considerably. A recent scoping review highlighted the potential clinical value of technologies like electromyography (EMG), accelerometers, three-dimensional imaging techniques and computer vision in gait analysis.[9] Despite this evidence, quantitative gait analysis technologies are still not commonly found in clinical practice settings.[10] While many factors can influence the clinical use of gait technologies, technology adoption research suggests a comprehensive understanding of clinical efficacy (i.e., efficacy and effectiveness), and a clinician's perspective on using the technology (e.g., acceptability) to be essential.[11,12]

Clinical efficacy studies consist of efficacy and effectiveness research – both of which are important for determining the impact on clinical outcomes and safety of an innovation as well as how it performs under real world circumstances.[13] These studies are often an important step in an iterative process of bringing an innovation from research to practice settings.[11] Clinical efficacy studies are important to help clinicians identify best practices and potential benefits to patient outcomes. A systematic review completed by Wren et al. 2011,[14] found some evidence to support that gait analysis technologies have a role in improving patient outcomes, which was further confirmed in their review update in 2020.[15] The authors also identified a small body of research that examines the role of gait analysis in influencing treatment decisions, with an example being their potential to reduce inappropriate treatments given to patients.[16] However, this review did not consider clinician perspectives on the use of gait analysis technologies in practice, which is fundamental for technology adoption, and their updated review in 2020 focussed only on three-dimensional gait analysis and was limited to a single database.

The Technology Acceptance Model (TAM) posits that ease of use and usefulness are important considerations for successful technology uptake.[12] Perceived ease of use is defined as "the degree to which an individual believes that using a particular system would be free of physical and mental effort".[12] Perceived usefulness is defined as "the degree to which an individual believes that using a particular system would enhance his or her job performance".[12] The TAM has been used in health research investigating the adoption of various medical technologies including electronic medical records and telehealth practices and has also been used to map systematic review findings related to tele-neurorehabilitation. [17–19] Beyond ease of use or usefulness, other factors that may influence clinical adoption of gait technologies include clinician perspectives on the logistics of acquiring the technology in their clinical setting, and administrative or organizational factors.[20]

To support the clinical adoption of gait analysis technologies for adult patient populations, the objective of this scoping review is to synthesize the literature on clinical efficacy and clinician perspectives. We believe this question is best suited for a scoping review because we wish to understand the extent of the literature on this topic and to consider a variety of study designs (e.g., quantitative, and qualitative study designs).[21,22]

## REVIEW QUESTIONS

The primary questions addressed by this scoping review are:

1) What is the extent of the literature on the clinical efficacy of quantitative gait analysis technologies in adult patient populations?
2) What are clinician perspectives on using quantitative gait analysis technologies in the clinical care of adult patient populations?

## METHODS

This scoping review followed the Joanna Briggs Institute methodology for scoping reviews.[23] The scoping review objectives, inclusion and exclusion criteria and methods were described in advance and documented in a protocol.[24] The reporting of results conforms to the Preferred Reporting Items for Systematic reviews and Meta-Analysis – Scoping Review (PRISMA-ScR) checklist.[25] Records were identified using the Population, Concept and Context criteria as outlined by the Joanna Briggs Institute methodology.

*Population:* Both patient populations and health care professionals were included in this review. Patient populations included adults (>18 years) with medical conditions such as neurological, cardiovascular or musculoskeletal conditions. Healthy adults were excluded. Health care professionals such as physiotherapists, medical doctors or exercise professionals were also included.

*Concept:* The three concepts in this review were: 1) quantitative gait analysis technologies 2) clinical efficacy and effectiveness and 3) clinician perspectives on the use of gait technologies in practice. We defined gait analysis technologies as those used to quantitatively measure the gait cycle (e.g., kinetic, or kinematic data) for the purposes of assessment and monitoring. We acknowledge that these technologies have many uses outside of gait analysis, however, for the purpose of this paper, we will be using the term "gait technologies" to identify technologies used for the purpose of gait analysis. Studies investigating gait training technologies or technologies used only to measure activity level or step counts were excluded. Additionally, studies of gait analysis technology in the developmental or validation stage were excluded. The definition of clinical efficacy (i.e., diagnostic thinking and treatment efficacy and patient outcomes) used in this review was outlined by Wren et al. 2011.[14] Thus, studies were included if they investigated how clinicians use gait technologies (e.g., treatment planning) and/or measured the impact to patient outcomes. The term efficacy will be used in this paper to describe both efficacy and effectiveness trials. Clinician perspectives on the use of gait technologies in practice included perceptions of barriers and/or facilitators to technology ease of use and usefulness and barriers and/or facilitators beyond ease of use and usefulness (e.g., training or environment).

*Context:* The context of this scoping review included "clinical care" which encompassed a wide range of settings like hospitals and community care (e.g., home and private clinic). This review included primary research studies (quantitative and qualitative work), and conference abstracts. Secondary research studies (e.g., systematic reviews) and other gray literature (e.g., textbooks and dissertations) were excluded from this review. Additionally, studies and conference abstracts were excluded if there were no substantial results reported.

**Search Strategy**

We completed a three-step search strategy.[23] The first step included hand searching studies in PubMed and Google Scholar. Example search terms included gait technologies AND clinical care, gait analysis AND barriers and gait technologies AND clinician perspective. The second step involved working with an information specialist to develop a comprehensive search strategy to identify studies and abstracts in the following five databases: MEDLINE (Ovid), CENTRAL (Ovid), EMBASE (Ovid), CINAHL (EBSCO) and SPORTDiscus (EBSCO). The third and final step involved looking through the reference list of included literature and relevant review articles, and a search in PEDro and Google Scholar using similar keywords to what was described in the first step. An example search strategy can be found in Supplementary Material A.



**Description of Source Selection**

We included peer-reviewed and gray literature (i.e., conference abstracts) in the English language from inception of the database until the end of December 2022. Covidence software (Veritas Health Innovation, Melbourne, Australia) was used to manage the review process. After pilot testing screening processes for title and abstract and then full-text, the first two authors (YS and LC) independently screened all studies and abstracts. A third reviewer (AI) assisted with conflict resolution.

## Critical Appraisal

Critical appraisal tools were piloted by the first two authors (YS and LC). The remaining studies were split between both authors where one performed the critical appraisal, and the other reviewed the appraisal for accuracy. Conference abstracts were not included in the critical appraisal phase.

## Data Extraction

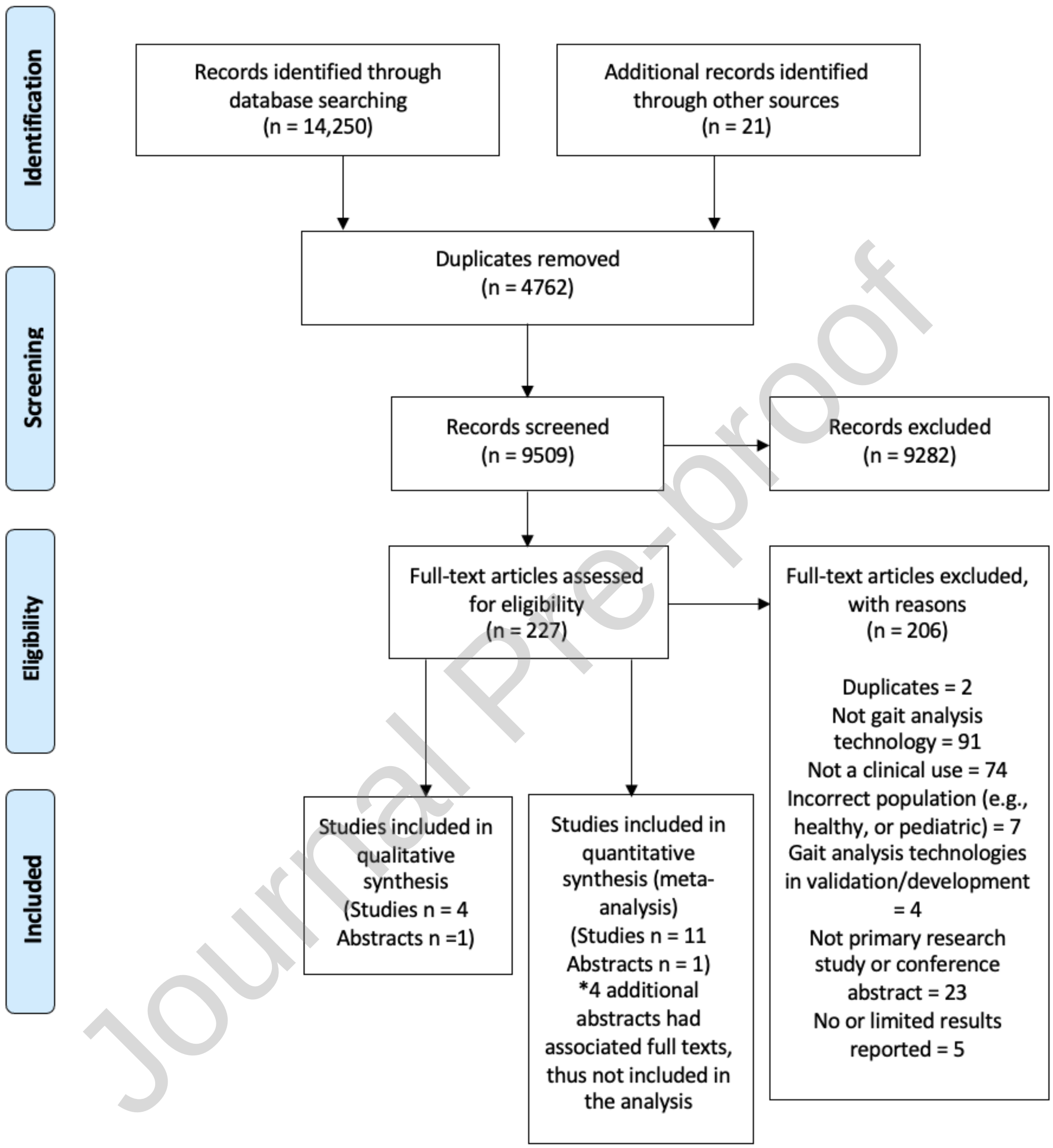
The first two authors (YS and LC) pilot tested the data extraction form and made modifications to the form as needed. The studies and abstracts included in this review were split between both authors, where one was responsible for extracting data, and the other reviewed the extraction for accuracy. In instances where a study or abstract discussed technologies other than gait analysis (e.g., balance technologies), only information pertaining to the gait analysis technology was extracted.



# RESULTS

The initial search yielded 14,271 records. After de-duplication, 9509 records were screened at the title and abstract phase, and 227 at the full-text stage. A total of 21 records were included in the final review, of which six were abstracts (Figure 1). Of the six abstracts, four were associated with full texts already included in this review. Therefore, only 17 records were included in the analysis of this review. Included studies were from the United States (5, 29.4%), Italy (3, 17.6%), Canada (2,11.8%), United Kingdom (2, 11.8%), Australia (2, 11.8%), Brazil (1, 5.9%), Spain (1, 5.9%) and Japan (1, 5.9%). A mix of both quantitative (n=12) and qualitative studies (n=5) were included in this review. Quantitative study designs included two randomized controlled trials, [26,27] one pre-post design clinical study,[28] three observational studies,[29–31] one retrospective observational study,[32] one retrospective case series,[16] one case report,[33] two feasibility studies,[34,35] and one abstract did not describe their study design.[36] Two qualitative studies reported a qualitative descriptive approach,[37,38] while three did not describe their approach to qualitative analyses. Studies of clinical efficacy and effectiveness, and clinician perspectives are summarized in Table 2 and Table 3 respectively. Results of the critical appraisal can be found in Tables 3-8.

**Figure 1.** PRISMA flowchart describing the process of study selection.



## Clinical Efficacy and Effectiveness

*Impact on clinical decision-making*

Four studies and one abstract focused on the use of gait technologies to inform clinical decision-making, such as assessment or treatment planning. Gait analysis technologies both guided and altered treatment plans for people with stroke, upper motor neuron syndrome, spinal cord injury, and Parkinson's Disease.[16,29,30,36] In two prospective observational studies, treatment recommendations changed for over 60% of patients (71% of patients with stroke and on average 64% of patients with upper motor neuron syndrome) when using gait analysis technologies such as 3D gait analysis,[30] force platforms and dynamic electromyography (EMG)[29] to inform treatment decisions. After using 3D gait analysis in decision-making for people with stroke, clinicians' confidence in their treatment plans improved significantly.[30] Retrospectively, use of a motion capture and wireless EMG system altered 14.6% of treatment recommendations for patients with stroke who had stiff knee gait and facilitated more detailed and specific treatment plans for the clinicians.[16] For people with Parkinson's Disease, an abstract showed a quantitative Timed Up and Go (QTUG) helped clinicians to adjust therapies and treatments.[36] A case report demonstrated that use of an Apple Watch to measure gait velocity in combination with traditional assessment techniques (e.g., subjective history telling), prompted medical imaging and subsequent surgery after identifying a recurrent disc herniation in a 39-year-old male.[33] Lastly, a randomized controlled trial used data from environmentally embedded sensors to alert nursing staff in assisted living centers of changes in patient gait patterns and the occurrence of falls to help them decide whether further patient assessment was needed.[27]

*Impact on patient outcomes*

Two studies examined gait analysis technologies as an intervention to measure and share objective gait data between therapist and patient. The aim was to improve patient motivation (e.g., to increase training), therapist-patient communication, and a patients' subjective impression of the gait intervention.[26,28] A pre-post intervention study revealed that self-reported motivation was significantly greater amongst patients with stroke who received feedback from their therapists about their gait pattern. The feedback given was based on the gait data collected from the wearable vibrotactile biofeedback device and foot pressure-sensing insole. [28] However, in a randomized controlled trial where gait data from a wireless inertial sensor system was used to motivate patients with stroke to practice more skills, the treatment group did not significantly differ in walking outcomes (e.g., average daily time spent walking, or 15-minute walk speed) compared to the control group.[26]

Patient outcomes were also investigated in several studies that used gait analysis technologies to inform clinical decision-making. In a previously mentioned retrospective study, it was found that 74% and 45% of ineffective treatments (i.e., use of botulinum toxin injection) could be avoided in people with spinal cord injury when using gait kinematics and dynamic EMG data respectively.[32] In the two prospective observational studies that investigated the impact of gait analysis on treatment planning, only one provided detail on patient outcomes. Results showed that after evaluating 36 patients with equinovarus foot deformity, 25 required surgery after consideration of gait data from motion capture system, force platforms and dynamic electromyography, and only one patient reported a "mild recurrence of a dynamic equinus deformity".[29] Using surgical plan agreement between multiple surgeons as a marker of better care, this same study found an increase in surgical plan agreement after the use of gait analysis technologies.[29] The randomized controlled trial investigating the impact of environmentally embedded sensor data on early detection of illness or functional decline in older adults in assisted living centers, reported no statistically significant differences between intervention and control groups in walking speed, velocity, bilateral stride and step length over 1-year, however, the differences trended towards the intervention group.[27] No significant differences were also found between the control and intervention groups for the following variables: number of falls, emergency room visits, hospitalizations, nursing home stays, medical doctor visits and health care costs. The previously mentioned abstract, provided evidence in support of using the QTUG to identify the correct dosage of Deep Brain Stimulation while avoiding side effects such as walking or balance impairments.[36] Lastly, in the single case report study, the patient's gait velocity, distance travelled, and step count progressed at a level comparable to before their recurrent episode of disc herniation after having surgery that was prompted by use of an Apple Watch and other assessments.[33]

**Clinician perspectives**

Of the seven studies focusing on clinician perspectives (five qualitative and two feasibility studies), two had clinicians discuss gait analysis technologies without using them in practice, [38,39] and five involved the clinicians using the technology in their practice.[34,35,37,40,41] The professional groups included in the studies were physiotherapists, exercise and care professionals, medical doctors and "health care providers". Where possible, the health care professional that contributed an opinion to a category described below has been indicated.

**Clinician perspectives: Ease of Use**

*Do clinicians perceive quantitative gait analysis technologies easy to use?*

The main barrier for ease of use of gait technologies was lack of data expertise. Lack of data expertise described a clinician's difficulty with understanding and interpreting data. Three studies identified a physician's and physiotherapist's lack of knowledge and difficulties with data interpretation to negatively influence the use of motion capture, pressure sensitive walkways and surface electromyography in people with stroke and spasticity.[31,37,41] Physicians using motion capture for people with spasticity did not feel they had sufficient knowledge to interpret the data being generated, which occasionally resulted in feelings of anxiety. They also considered motion capture be a "test of the engineers".[41] In one study, physiotherapists using surface electromyography for people with stroke were unacquainted with the assessment technique and did not have sufficient knowledge to "recognize artifacts and interferences or process the signals",[31] and in a second study, physiotherapists using gait and balance technologies such as pressure sensitive walkways, experienced challenges interpreting data stating "I'm still struggling with it, it's not, it's still not easy…".[37]

Having support was considered invaluable for physicians and physiotherapists who experienced challenges with gait analysis technology assessments.[37,41] Thus, one of the main facilitators to quantitative gait analysis technology ease of use was support from staff and technology experts. Physicians felt that two clinical staff were considered valuable when organizing a motion capture gait test,[41] to allow for both supporting the patient (e.g., explaining the use of the device, placing electrodes), and operating the technology. Lastly, physiotherapists felt clinic support staff were beneficial for all aspects of technology management, managing the equipment, and processing the data when using pressure-sensitive walkways and balance technologies for assessments of people with stroke.[37]

Finally, it was interesting to note that time commitment and the need for additional training had conflicting clinician perspectives. In a study investigating the feasibility of using a ProtoKinetics GaitMat to evaluate gait in an outpatient neurology clinic, clinical assistants (i.e., Doctor of Physical Therapy students and nurses) reported conducting the gait evaluation to be “very acceptable” or “acceptable”.[34] This same study listed the time needed to train clinical assistants on technology setup, protocol and data processing was between 15-22 minutes, and the time needed each day to set up and calibrate the system, was 2 min ± 30 seconds. Additionally, on average, it took clinical assistants 3 mins and 35 secs (± 2 mins and 01 secs) to complete the gait assessment. Another study using radio frequency identification-based (RFID) to measure gait speed in older adults at an outpatient geriatric clinic, had one healthcare provider stated “using the radio-frequency identification-based device interrupted the flow of office procedures”, but no healthcare provider felt burdened by this assessment in practice.[35] Physiotherapists felt the time constraints that already existed in their clinical environment would hinder the use of gait analysis technologies in their practice. Physiotherapists who used pressure sensitive walkways and balance technologies with people with stroke were concerned about the time needed to complete the assessment when patients already have short hospital stays and high intensity rehabilitation schedules.[37] There were also conflicting clinician perspectives about the need for additional training. Exercise professionals working in long-term care centers typically have volunteers who work alongside them. These clinicians felt that needing to do additional training could be a challenge in this type of environment because of concerns with high volunteer turnover rate and limited available resources.[38] However, in a previously mentioned study with clinical assistants using the ProtoKinetics GaitMat, additional training needed for setting up, operating, collecting and processing the data was perceived to be "acceptable" or "very acceptable".[34]

**Clinician perspectives: Usefulness**

*Do clinicians perceive quantitative gait analysis technologies to be useful?*

The three main barriers to usefulness we identified were challenges with finding suitable reference data, feasibility of gait assessment with technology dependent on patient populations, and data accuracy. When considering the use of technology in long-term care settings (e.g., accelerometers), exercise professionals were concerned with the lack of normative data that would be available to use as a comparison for their patients because of their wide variety of functional abilities. Ultimately, exercise professionals working in long-term care felt this lack of reference data would make it challenging to find meaning in the output.[38]

Next, exercise professionals felt the feasibility of gait analysis technologies was dependent on the patient population. In the same study discussed above, exercise professionals felt the feasibility of using gait and balance technologies was dependent on the patients' cognition and whether they would be able to stay attentive and follow instructions on device usability.[38]

The final barrier to usefulness identified was data accuracy. Physiotherapists were concerned with the precision of data gathered from wearable gait technologies stating they "are not as good as cameras, will not give us same precise data". These physiotherapists reported having issues with "trust" in these technologies when compared to non-wearable technologies such as instrumented walkways, largely because they felt the data would need processing by themselves – people who are not experts.[39]

We identified three main facilitators to the usefulness of gait analysis technologies which were enhancing patient care, supporting clinical decision-making, and improving multidisciplinary communication channels.

Enhancing patient care encompassed how gait analysis technologies can be used as a tool to motivate, educate, and encourage self-management in patients.[37,38,40,41] In a previously mentioned study with physiotherapists using pressure sensitive walkways for people with stroke, physiotherapists saw value in providing patients with the objective data received from the technology to allow patients to better understand their abilities.[37]

Next, use of quantitative gait analysis technologies were seen as a way to support clinical decision-making. For example, gait analysis technologies were seen as a tool that can guide treatment planning[27,41] and support clinical reasoning and/or decision making.[37,38,41] Nursing staff working in assisted living centers found data provided by environmentally embedded sensors to be beneficial in understanding their patients' well-being post-fall and whether there was a need to conduct further assessment.[27] Interestingly, exercise professionals in long-term care felt objective gait data could help them create more individualized treatment plans,[38] physiotherapists in one study felt these technologies helped them create more individualized patient treatment plan [40] and in one other study, physiotherapists using gait and balance technologies such as a pressure sensitive walkway for people with stroke felt the use of gait analysis technologies would not alter their programs but would assist them in tracking progress more accurately.[37]

The final facilitator to the usefulness of gait analysis technologies in practice was improved multidisciplinary communication amongst health care professionals, patients and their families.[38,41] Physiotherapists and doctors felt gait data could potentially be integrated into patient medical records, [38,41] ultimately enhancing interdisciplinary communication. Exercise professionals in long-term care felt having this objective gait data to be more beneficial for patient families since the patients in their clinical setting may have difficulties understanding and interpreting the data given the presence of cognitive impairment.[38]

**Clinician perspectives: Beyond ease of use and usefulness**

Beyond ease of use and usefulness, clinicians discussed barriers to using gait analysis technologies in clinical practice to be associated with their cost, and patient-related barriers,[39]. Physiotherapists discussed cost as a barrier to using gait technologies in clinical practice, even technologies considered "low cost" in other areas of the world with one therapist saying "…whenever we say R$500 (80 pounds/100 pounds) it's not that cheap for us.". [39] The main patient-related barrier was a patient's lack of understanding of the role gait assessments and wearable technologies in physical therapy.[39] Finally, physiotherapists felt there was a lack of administrative support for those therapists interested in using innovations in their practice, and in some cases, physiotherapists felt there was a lack of collaboration and appreciation for objective assessments amongst colleagues. Taken together, physiotherapists felt these factors negatively impacted the use of wearable gait technologies in their practice.[39] One facilitator identified beyond ease of use and usefulness was related to ease of implementation, where one study with health care providers using RFID tags to measure gait speed in a clinical setting reported that 7 of the 9 providers agreed or strongly agreed that "it would be easy to implement routine use of the RFID device to measure gait speed as part of usual care in our office".

This review did not comprehensively search for barriers and facilitators beyond clinician perspectives (e.g., administrative, or technological barriers and facilitators). However, some of these barriers and facilitators were briefly mentioned in the studies included in this review. Example barriers to quantitative gait analysis technology use in practice were related to technology and network issues, patient adherence (e.g., fatigue), and time constraints.[26,27,39] Other facilitators included positive patient experiences (e.g., comfort of sensors on body), and potential cost savings.[26,27,29,32]

## Role of technology, patient population and clinical setting

Figure 2 outlines the factors influencing the clinical adoption of gait analysis technologies while taking into consideration the type of gait technology, patient population and clinical setting.

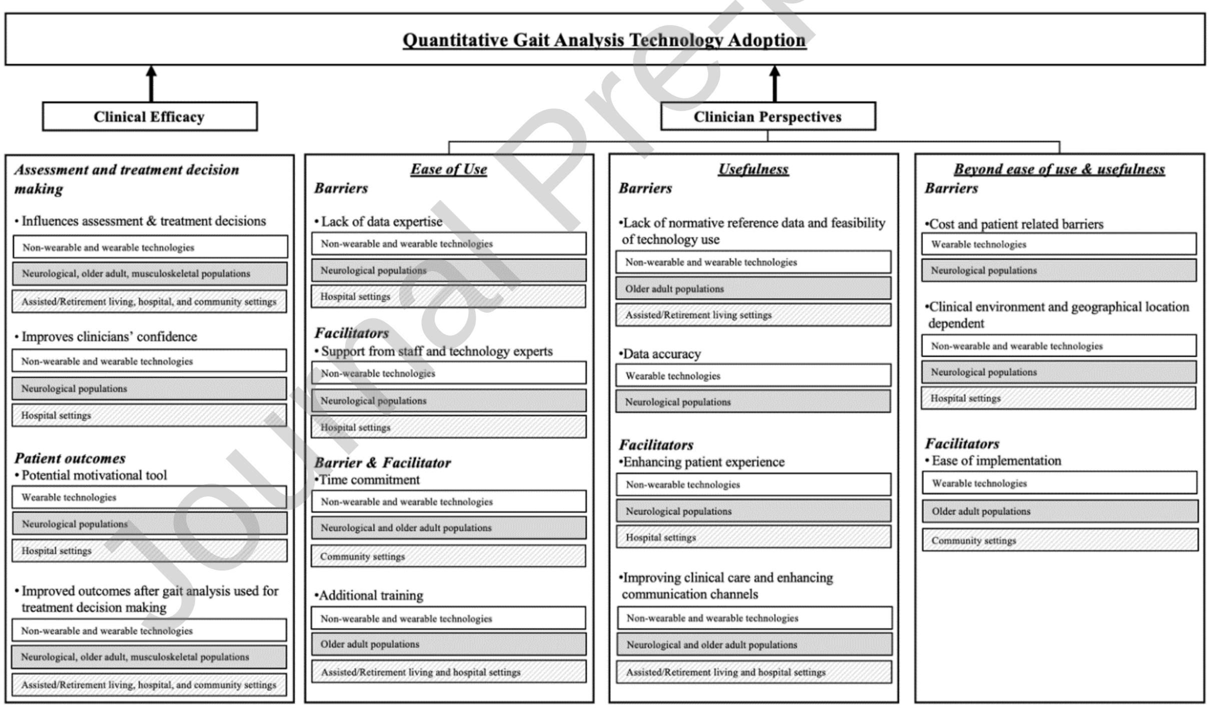



**Figure 2.** Factors influencing the clinical adoption of gait analysis technologies while taking into consideration technology type, patient population, and clinical setting.

Studies investigating the role of gait technologies on patient motivation only used wearable gait technologies. The majority of studies investigating the role of gait analysis technologies were conducted in patients with neurological disorders and in hospital settings (e.g., inpatient rehabilitation). Additionally, time commitment and need for additional training appeared both as perceived barriers and facilitators to gait analysis ease of use.

**DISCUSSION**

This scoping review investigated factors influencing gait analysis technology adoption, with a focus on clinical efficacy and clinician perspectives. We found that gait analysis technologies had a role in guiding assessment and treatment decisions for a variety of patient populations and some evidence suggested their role in patient motivation and improving patient outcomes. Mapping clinician perspectives to the TAM showed the main barrier for ease of use of gait technologies was lack of data expertise and the main facilitator was having support from staff and technology experts. Time commitment and need for additional training were both barriers and facilitators to gait technology ease of use. The three main barriers to usefulness were challenges with data accuracy, finding reference data, and the feasibility of using the gait analysis technology dependent on the patient's abilities. The three main facilitators to gait technology usefulness were enhancing patient care, supporting clinical decision-making, and improving multidisciplinary communication channels. Many gait analysis technologies were included in this review and two major gaps were found in the literature: the lack of efficacy research and studies investigating clinician perspectives that could be mapped to the TAM. Taken together, these gaps reveal opportunities to improve the clinical adoption of gait analysis technologies into practice.

A variety of gait analysis technologies (e.g., wearable sensors to motion capture), capturing a range of data (e.g., kinematic and kinetics), with different applications (e.g., tracking progress, motivation and clinical decision making) were used in the included studies. Non-wearable technologies like motion capture were largely used in studies to support clinical decision-making. [16,29,30,32] Motion capture can collect data related to gait kinematics and spatiotemporal gait parameters and is considered the gold standard for identifying gait impairments, however, its' benefits are offset by the cost, complexity and resources needed.[8,42] Studies included in this review using motion capture tended to be based at institutions with dedicated gait analysis centers. [16,29,30,32] In this review we found that motion capture, force plates, and EMGs used together influenced treatment plans and improved patient outcomes. Gait analysis clinical efficacy research in paediatric populations also had similar findings, however, some did not report using EMGs.[43–49] An example of a wearable technology included in this review were inertial sensors used to track patient activity to support motivation.[26] The accuracy and precision of wearable inertial sensors is dependent on patient setup, and the algorithms needed to extract meaningful information from the sensor data.[8,50] Interestingly, use of wearable sensors (e.g., inertial sensors) for tracking outcomes and for patient motivation was more common in studies in adults,[26,28,33] compared to paediatrics.

The nine studies included in this review were a combination of observational study designs (e.g., case reports and case series) and RCTs. The pediatric literature similarly consists of a small number of controlled trials, and a larger number of lower quality cohort studies.[15] Case report and case series studies have a high risk of bias and misinterpretation and are difficult to generalize to a broader population.[51] Limitations also exist for the RCTs included in this review. For example, neither one investigated the impact of loss to follow up on the analysis or found statistically significant differences between groups and both were likely underpowered. The effect size of interventions designed to improve approaches to assessment or diagnosis are often small, although still clinically important, and this can make it difficult to conduct adequately powered RCTs.[52] In addition to these limitations, RCTs are also generally expensive, time consuming, face challenges with participant recruitment and retention, and may lack in generalizability.[53–55] To overcome these limitations, different study designs should be considered. For example, pragmatic clinical trials are designed to test the effectiveness of an innovation in a real-world context. Pragmatic clinical trials do not require formal exclusion criteria, allowing for a more heterogenous study population and better generalizability of results.[56,57] Beyond pragmatic clinical trials, diagnostic before-after studies can serve as a preliminary step to traditional RCTs. Before-after designs were found in this review,[29,30] and require fewer resources as compared to RCTs.[58] Because these study designs tend to favor the new technology, if no effect is found, it is unlikely one would be found in higher level evidence such as an RCT.[59] Some examples of these approaches used in healthcare research include studying the effectiveness of health technologies aimed at improving asthma medication adherence and online cognitive behavioural treatments.[60,61] Using pragmatic clinical trials and before-after study designs to study gait technologies may be of particular interest for researchers since the results of this review demonstrates that their effectiveness is dependent on type of technology, patient population and clinical context.

Finally, we found that few studies existed that could be mapped to the TAM which resulted in a limited understanding of what factors contribute to the ease of use and usefulness of gait analysis technologies for clinicians. For example, in this review three studies identified a lack of data expertise as a barrier to the adoption of gait analysis technologies by clinical staff, however, only one mitigation factor was identified across two studies– having support from additional staff. This demonstrates a lack of understanding of strategies that can help clinicians with data interpretation. Studies investigating the design of gait analysis technologies have identified the importance of having an output that has “no raw data”, a report of findings and/or normative values, and pictures and graphs to aid in their interpretation of the data[62–64]. [65,66]is for researchers to consider using a TAM lens when designing research studies aimed at gathering clinician perspectives. In health technology adoption literature, studies have investigated provider perception on technology acceptance (e.g., perceived ease of use and usefulness) using qualitative and quantitative measures. Example qualitative methods include analyzing journal data [65] and interviews,[66] while quantitative methods include a validated TAM questionnaire [67] and customized surveys.[68] Another interesting approach to investigating clinician perspectives may be to use a combination of qualitative and quantitative measures. An example of this can be seen in a research study investigating the acceptability and compliance of a food diary mobile application in young adults.[69] Here, the authors were able to quantitatively describe the level of acceptance of the mHealth application, while also providing qualitative information on what specific features of the application the young adults liked the most, or what barriers may exist during technology implementation. Since the development of the TAM, many extensions have been made to include more contextual factors. Examples of these models include the Extension of TAM (TAM2) and the Unified Theory of Acceptance and Use of Technology (UTAUT).[70] Thus, there are plenty of theoretical models that researchers can choose from that most appropriately explain the acceptance of different gait technologies in a variety of clinical settings. Ultimately, researchers need to use an appropriate theoretical model to guide and improve the quality of their technology evaluation studies using to help with the successful integration of gait technologies into clinical practice and support their long-term adoption.

This scoping review has its limitations. First, this review did not include patient perspectives or barriers and facilitators beyond a clinician's perspective in the search strategy (e.g., impact of organizations and policy), though these are recognized as influencing factors to technology adoption elsewhere.[11,71] Secondly, this review only considered conference abstracts as a source of gray literature. Because the use of gait analysis technologies in practice is a growing field of research, it is likely that many other forms of gray literature (e.g., thesis dissertations) would have addressed this topic in detail. Thirdly, to be a comprehensive review, studies that discussed multi-use technologies (e.g., measured gait, balance, and mobility) were included. Thus, some of the clinician perspectives discussed in this review may have been attributed to the aspects of the technology unrelated to the gait component. To mitigate this risk, the first author did their best to report on clinician perspectives that were explicitly described as related to gait. Finally, this review only included studies written in the English language, therefore relevant studies in other languages may have been missed.

## CONCLUSION

This scoping review found evidence in support of gait analysis altering treatment decision making and impacting patient outcomes. Additionally, this work mapped clinician perspectives to the TAM to summarize findings in relation to technology ease of use, usefulness, and factors beyond ease of use and usefulness. Overall, successful technology adoption requires a balanced approach to understanding how the technology performs (i.e., efficacy) and how these technologies can be accepted by the individual responsible for applying them in a practice setting. Findings from this review provide the necessary step in improving technology adoption by highlighting barriers that need to be overcome and guidance for where future research should focus their efforts.

## CONFLICT OF INTEREST STATEMENT

There are no conflicts of interest to declare.



**Table 1. Description of studies primarily focused on clinical efficacy (i.e., efficacy and effectiveness)**
**(Studies (n=8); Abstract (n=1)**

| Author & year | Study design | Objective | Gait Tech | Patient | Clinician | Patient sample size (N) | Setting | Impact on treatment & Patient outcomes | Barriers & facilitators |
|---|---|---|---|---|---|---|---|---|---|
| Dorsch et al. 2015 *2 abstracts | Randomized single blind clinical trial | "To test the feasibility of providing quantitative feedback about daily walking performance and motivating greater skills practice via remote sensing." | Wireless inertial sensor system | Stroke | Therapists | Control group: N= 73 Women =28 Men=45<br><br>Experimental Group: N=78 Women =31 Men=47 | Inpatient rehab centers (12 international, 4 American) | Patient outcomes: No significant differences between intervention (activity graph feedback) and control group for the following measures: primary outcomes (average time spent walking (daily), 15-m walking speed), and secondary or self-report outcomes (Functional Ambulation Category, 3-minute walking distance and Stroke Impact | External Barrier: Gait analysis technology malfunctioning (e.g., hardware failure)<br><br>External Facilitators: Study participants reported sensors were comfortable (87%) and had little to no impact on their movement (97.6%) |

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| | | | | | | | | Scale-16 scores). | |
| Ferrarin et al. 2015 *1 abstract | Pragmatic prospective observational study | "To assess the impact of GA on clinical decision-making in adult chronic poststroke patients." | 3D gait analysis | Chronic Stroke | Clinicians who were "expert users of gait analysis" | Control group: N=20 Female=11 Male=9<br><br>Patient group: N=49 Female=15 Male=34 | Rehab hospital, both outpatients and inpatients | Treatment outcomes: Treatment recommendations changed in 35/49 patients (71%) after use of gait analysis<br><br>Clinician confidence level increase 2.0±1.2 points (mean±SD) after use of gait analysis data in all 49 patients | n/a |
| Fuller et al. 2002 | Prospective observational study | "To determine the influence of gait analysis with dynamic electromyography upon surgical planning in patients with upper motor neuron syndrome and a spastic equinovarus deformity" | Motion capture system, two force platforms, and dynamic EMG | Adult patients with upper motor neurone syndrome with equinovaru-s foot and ankle deformity | Attending neuro-orthopaedic surgeons | N=36 Female=15 Male=21 | Unspecified | Treatment outcomes: 64% of surgical plans were changed after use of gait analysis<br><br>Patient outcomes: In the 25 surgically treated patients, none had a return of equinovarus foot deformity, and all were content with the surgery. One patient had a mild recurrence dynamic equinus deformity, | n/a |

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| | | | | | | | | but not a varus deformity.<br><br>Quality of care plan as defined as change and agreement between surgical plans increased significantly after use of gait analysis | |
| Murphy et al. 2019 | Retrospective case series | "The aim of our study was to: (1) investigate how 3DGA impairment based reporting guides individualised clinical decision-making regarding gait optimisation in people with incomplete SCD and (2) to determine the quality of gait in patients with SCD." | 2D video along walkway, 3D video (Vicon), and force plates | Spinal cord injury | Senior physiotherapists, rehabilitation physicians, orthotists, bio mechanists | N=48 Female=11 Male=37 | | Treatment outcomes: Referrals to gait analysis primarily made to determine the best treatment plan (54%)<br><br>Of the referrals with specific treatment plans formed, recommendations post-gait analysis altered these plans in 7 patients (14.6%)<br><br>Most common treatment plan suggested post-gait analysis was use of an ankle-foot orthosis | n/a |

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| Mobbs et al. 2018 | Case report | To demonstrate the role of gait analysis in assessment decisions. | Apple Watch | 39-year-old male with sciatica who had an L5/S1 microdiscec-tomy and was monitored with gait technology pre- and post-surgery | | N=1 Male=1 | Community | Treatment outcomes: Apple Watch data (worsening gait velocity and activity levels) in combination with subjective history led to an MRI and subsequently a redo surgery for the patient.<br><br>Patient outcomes: Patient continued to progress as expected (e.g., similar rate to recovery prior to identification of recurrent disc herniation) | n/a |
| Rantz et al. 2017 | Prospective intervention study | “To measure the clinical and cost effectiveness of using sensor data to detect early signs of illness or functional decline in a randomized sample of older adults living in assisted living (AL) communities as compared to usual health assessment | Environmentally embedded sensors that assess for increasing falls risk. | Residents in assisted living | Nurses | Control group: N=85 Female=62 Male=23<br><br>Experimental group N=86 Female=64 Male=22 | Assisted living centers | Treatment outcomes: Nursing staff used information from sensors along with their clinical reasoning to identify residents who needed further | External barriers: Technology issues (e.g., network and internet connection problems)<br><br>External facilitators: Fall alerts functioned well because able to bypass network concerns |

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| | | methods of older adults living in those same AL communities.” | | | | | | assessment.<br><br>Patient outcomes: The control group performed worse in the following gait parameters as compared to the intervention group: walking speed, velocity, bilateral stride length and bilateral step length, functional ambulation profile. These were clinically significant changes.<br><br>No significant differences in the following measures between control and intervention group: falls, ER visits, hospitalizations, nursing home stays, and physician visits, health care costs. | à limited unnecessary resident room checks Residents felt a sense of security<br><br>Clinician perspective: Technology is helpful in understanding resident status (e.g., fallen or not fallen) and perceived the data to be clinically relevant |
| Saichi et al. 2016 | Pilot clinical evaluation | “To describe the design and pilot | Wearable vibrotacti-le | Stroke | Physical therapist | N=6<br><br>Control group | Rehab center | Patient outcomes: Significantly higher | n/a |

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| | | clinical evaluation of a gait rehabilitation program using a haptic BF device for sharing information regarding the foot pressure pattern between a patient and physical therapist.” | BF device and a foot pressure-sensing insole | | | (biofeedback not shared with therapist): N=3<br><br>Experimental group (biofeedback shared with therapist): N=3 | | motivation and slight decrease in task difficulty amongst participants who had their foot pressure pattern shared with therapists<br><br>No notable differences between the intervention (data shared with therapist) and control group for the following measures: feelings of anxiety, accomplishment, conversation, understanding walking characteristics. | |
| Merlo et al. 2019 | Observational retrospective study | “To assess the percentage of inappropriate treatments (PIT) that can be avoided when instrumental gait analysis (GA) is used, and to estimate the associated cost savings.” | Motion capture and wireless EMG system | Stroke patients with stiff knee gait | n/a | N=160 Female=71 Male=87 | n/a | Treatment outcomes: 74% of ineffective treatments could have been avoided if using gait kinematics<br><br>45% of ineffective treatments could have been avoided if using dynamic EMG during gait | External facilitators: Cost savings estimated between €105k – €130k/year when using gait analysis to inform treatment decisions for people with stiff knee gait (Assuming treating 100 patients |

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| | | | | | | | | | with stiff knee gait/year) |
| Somerset et al. 2019 | Not reported (Abstract) | “To increase the speed and objectivity of decision making for patients with Parkinson’s disease and gait impairments, undergoing deep brain stimulation (DBS), using the quantified timed up and go (QTUG) device.” | QTUG | Parkinson’s Disease (with DBS) | Unknown | N=3 | Unspecified | Treatment outcomes: Supported clinicians’ when determining appropriate level of DBS<br><br>Patient outcomes: Improvements in gait measures (e.g., speed), falls risk and frailty in three patients | n/a |

*=The number of abstracts associated with the full texts found in the search. Abstracts where full texts were found were not included in the data extraction process and not reported in this table.

**Table 2. Description of studies primarily focused on clinician perspectives (Studies (n=7), Abstract (n=1)**

| Author & year | Objective | Study design | Gait tech | Patient | Clinician | Clinician sample size (N) | Themes related to perceived barriers, and facilitators to ease of use, usefulness, and factors beyond usability |
|---|---|---|---|---|---|---|---|
| Barry et al. 2018 *1 abstract | “To evaluate the feasibility, acceptability, and validity of a radio-frequency identification (RFID)-based system to measure gait speed in | Feasibility study | Radiofrequency identification-based approach (RFID tags) | Geriatrics | Healthcare providers | N=50<br>Female=33<br>Male=17 | 1. No burden from assessment<br>2. Easy to implement<br>3. Potential workflow interruption |

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| | a clinical setting” | | | | | | |
| Godfrey et al. 2020 | “To examine pragmatic issues and challenges in the use of wearables in a diverse, low-resource, middle-income country like Brazil.” | Qualitative study | Inertial-based wearable technology | Unspecified | Physiotherapists with background in clinical neurology | N=2 Female=1 Male=1 | 1. Regional inequalities: wealth, culture, education 2. Resources and knowledge exchange 3. Trust, reference standards |
| Marin et al. 2019 | To extract design considerations and generate guidelines to integrate MoCap technology for gait analysis in the hospital rehabilitation setting. Specifically, the aim is to design a gait test to assess the response of the applied treatments through pre- and post-measurement sessions. | Qualitative study | MoCap | Patients with spasticity when they receive treatment with botulinum toxin | Rehabilitation specialist doctor and resident doctor | N=29 | 1. Patients' understanding 2. Guiding the gait tests 3. Which professionals guide the gait tests 4. Gait test reports 5. Requesting gait tests (doctors and test guide communication) 6. Conceptual design of the service with the gait test |
| Nicholas et al. 2019 | To evaluate physiotherapist experience and acceptance of the sensor-based movement feedback approach. | Qualitative study | Sensor-based movement analysis | ACL reconstruction | Physiotherapists | N=12 | 1. Usability of the clinical movement analysis report and future design considerations 2. Clinical integration and decision making 3. Behaviour change 4. Previous, current, future use and |

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| | | | | | | | environmental considerations towards using biomechanical technology in clinical practice |
| Nocera et al. 2019 | We report on the feasibility of implementing a gait assessment utilizing a gait mat in a cognitive neurology outpatient setting. | Feasibility study | ProtoKinetics Gait mat (PKMAS) | Patients attending the cognitive neurology clinic | Doctor pf physical therapy and rooming nurses | N=12 DPT Female: 75%<br><br>Rooming Nurse Female: 100% | 1. Acceptable gait test training |
| Pak et al. 2015 | To explore the perspectives of both physiotherapists and patients on the use of biomechanics technology in managing balance and mobility impairments after stroke. | Qualitative descriptive study | Pressure-sensitive walkway | Stroke | Physical therapists | N=4 Female=2 Male=2 | 1. Clinical applications of the assessment<br>2. Facilitators of and challenges to the use of technology<br>3. Communication between physiotherapists and patients |
| Van ooteghem et al. 2020 | To (1) understand exercise professionals' views regarding the integration of technology and the use of technology-derived data for balance and mobility assessment and (2) identify barriers and solutions to integrating technology | Qualitative descriptive study | Participants were introduced to sample technologies (e.g., accelerometers) | Residents living in retirement and long-term care settings | Registered kinesiologist, exercise therapist | N=18 Female=15 Male=3 | 1. Views on technology integration and use of technology-driven data<br>2. Barriers and solutions to technology integration |

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|---|---|---|---|---|---|---|---|
| | into balance and mobility assessment practices for older adults in a residential care setting. | | | | | | |
| Goffredo et al. 2020 | Observational study | "To assess the barriers to the implementation of a sEMG-based assessment protocol in a clinical context for evaluating the effects of o-RAGT in subacute stroke patients." | Surface electromy-ography (sEMG) | Sub-acute stroke | Medical doctors (physical medicine & rehabilitation specialists), physiotherapists, biomedical engineers | N=8<br>Female=3<br>Male=5 | External barriers and/or facilitators<br>1. Success rate of sEMG implementation: 22.7%<br>2. Patient-related barriers<br>3. Lack of physiotherapist knowledge of sEMG<br>4. Technical barriers<br>5. Administrative barriers |

*=The number of abstracts associated with the full texts found in the search. Abstracts where full texts were found, were not included in the data extraction process, and not reported in this table.

**Table 3.** Methodological quality of randomized controlled trials.

| Study ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dorsch et al. 2015** [26] | Yes | Yes | Yes | Unclear | Unclear | Yes | Yes | No | No | Yes | Yes | Yes | Yes |
| **Rantz et al. 2017** [27] | Unclear | No | Yes | Unclear | N/A | Unclear | Yes | No | Yes | Yes | Yes | Yes | Yes |

1. Was true randomization used for assignment of participants to treatment groups?
2. Was allocation to treatment groups concealed?
3. Were treatment groups similar at the baseline?
4. Were participants blind to treatment assignment?
5. Were those delivering treatment blind to treatment assignment?
6. Were outcomes assessors blind to treatment assignment?
7. Were treatment groups treated identically other than the intervention of interest?
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
9. Were participants analyzed in the groups to which they were randomized?
10. Were outcomes measured in the same way for treatment groups?

11. Were outcomes measured in a reliable way?
12. Was appropriate statistical analysis used?
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?

**Table 4.** Methodological quality of case reports

| Study ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
|---|---|---|---|---|---|---|---|---|
| **Mobbs et al. 2018**[33] | Yes | No | Yes | Yes | No | Yes | No | Yes |

1. Were patient's demographic characteristics clearly described?
2. Was the patient's history clearly described and presented as a timeline?
3. Was the current clinical condition of the patient on presentation clearly described?
4. Were diagnostic tests or assessment methods and the results clearly described?
5. Was the intervention(s) or treatment procedure(s) clearly described?
6. Was the post-intervention clinical condition clearly described?
7. Were adverse events (harms) or unanticipated events identified and described?
8. Does the case report provide takeaway lessons?

**Table 5.** Methodological quality of cross-sectional studies.

| Study ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 |
|---|---|---|---|---|---|---|---|---|
| **Nocera et al. 2019** [34] | Unclear | Yes | Yes | Unclear | No | No | Yes | Yes |
| **Goffredo et al. 2020** [31] | Yes | Yes | Yes | Yes | No | No | Yes | Yes |
| **Barry et al. 2019** [35] | Yes | Yes | Yes | No | No | No | Yes | Yes |

1. Were the criteria for inclusion in the sample clearly defined?
2. Were the study subjects and the setting described in detail?
3. Was the exposure measured in a valid and reliable way?
4. Were objective, standard criteria used for measurement of the condition?
5. Were confounding factors identified?
6. Were strategies to deal with confounding factors stated?
7. Were the outcomes measured in a valid and reliable way?
8. Was appropriate statistical analysis used?

**Table 6.** Methodological quality of case-series

| Study ID | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Murphy et al. 2019** [16] | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes |

1. Were there clear criteria for inclusion in the case series?
2. Was the condition measured in a standard, reliable way for all participants included in the case series?
3. Were valid methods used for identification of the condition for all participants included in the case series?
4. Did the case series have consecutive inclusion of participants?
5. Did the case series have complete inclusion of participants?
6. Was there clear reporting of the demographics of the participants in the study?
7. Was there clear reporting of clinical information of the participants?
8. Were the outcomes or follow up results of cases clearly reported?

9. Was there clear reporting of the presenting site(s)/clinic(s) demographic information?
10. Was statistical analysis appropriate?

**Table 7.** Methodological quality of quasi-experimental studies

| **Study ID** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** |
|---|---|---|---|---|---|---|---|---|---|
| **Saichi et al. 2016**[28] | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes |
| **Fuller et al. 2002**[29] | Yes | Yes | Yes | No | Yes | Unclear | Yes | Yes | Yes |
| **Ferrarin et al. 2015**[30] | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes |

1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?
2. Were the participants included in any comparisons similar?
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
4. Was there a control group?
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?
7. Were the outcomes of participants included in any comparisons measured in the same way?
8. Were outcomes measured in a reliable way?
9. Was appropriate statistical analysis used?

**Table 8.** Methodological quality of qualitative studies

| **Study ID** | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pak et al. 2015**[37] | No | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| **Van Ooteghem et al. 2020**[38] | No | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes |
| **Marin et al. 2019**[41] | Yes | Yes | Yes | Yes | Yes | No | No | Yes | Yes | Yes |
| **Godfrey et al. 2020**[39] | No | No | No | No | No | No | No | Yes | Yes | Yes |

1. Is there congruity between the stated philosophical perspective and the research methodology?
2. Is there congruity between the research methodology and the research question or objectives?
3. Is there congruity between the research methodology and the methods used to collect data?
4. Is there congruity between the research methodology and the representation and analysis of data?
5. Is there congruity between the research methodology and the interpretation of results?
6. Is there a statement locating the researcher culturally or theoretically?
7. Is the influence of the researcher on the research, and vice- versa, addressed?
8. Are participants, and their voices, adequately represented?
9. Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?
10. Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?

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**Declaration of Competing Interest**

none

Highlights

- Quantitative gait analysis technologies can influence decision-making
- Some evidence suggests the role of gait technologies in improving patient outcomes
- A barrier to technology ease of use was a clinician's lack of data expertise and a facilitator was receiving support from staff
- A barrier to usefulness was challenges finding suitable reference data and a facilitator was enhancing patient care