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REVIEW

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Exploring the potential of iPhone applications in podiatry: a comprehensive review

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Abstract

Background The integration of smartphones, particularly iPhones, into clinical podiatry practice has gained momentum, yet a comprehensive analysis of their potential and outcomes remains scarce.

Results We conducted a review to assess iPhones' utility in podiatry. Encompassing diagnostic imaging, measurement tools, telemedicine applications, and patient engagement, this review included studies meeting established criteria for evidence quality. Among the eight eligible studies, iPhones exhibited reliability in measuring angles, assessing foot and ankle morphology, and capturing ulcer images. Telemedicine apps enabled remote consultations and heightened patient accessibility. Interactive applications and self-monitoring tools enriched patient engagement.

Conclusion iPhones hold significant promise in clinical podiatry, offering portability, imaging, measurement, and telemedicine capabilities. Future research should focus on standardization, accuracy validation, security, and long-term impact. iPhones have the potential to reshape podiatric practice and enhance patient care.

Keywords iPhones, Clinical podiatry, Telemedicine, Measurement tools, Patient engagement

Introduction

Podiatry is a medical discipline that focuses on the assessment, diagnosis, and treatment of foot conditions. In recent years, the advancement of mobile technologies has led to the emergence of a wide range of applications available on devices such as the iPhone, offering innovative tools and functionalities to support podiatrists' clinical practice [1–3]. This scoping review aims to explore the potential of iPhone applications in podiatry, with particular attention to their clinical applications and the impact on podiatrists' professional practice. Various categories of applications will be examined, including those for biomechanical assessment, plantar pressure measurement, gait analysis, and wound management [4–11]. A fundamental aspect of this review will be the critical examination of the available scientific evidence regarding the effectiveness and reliability of such applications. Clinical studies, systematic reviews, and other research sources will be considered to evaluate the diagnostic accuracy and validity of the information provided by these applications. The ultimate goal of this review is to provide a comprehensive scientific overview of the use of iPhone applications in podiatry clinical practice, highlighting potential benefits and practical considerations for healthcare practitioners. This review can serve as a basis for discussion and guidance on the adoption of such technologies in the field of podiatry, aiming to enhance assessment accuracy and treatment efficacy provided to patients. Through rigorous evaluation of scientific evidence and critical discussion of practical implications, this review aims to contribute to the knowledge base in podiatry, enabling professionals to make informed

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decisions regarding the integration of iPhone applications into their clinical practice. This scoping review aimed to:

1. Explore the potential of iPhone applications in podiatry.
2. Examine the clinical applications of iPhone applications in podiatry.
3. Assess the impact of iPhone applications on podiatrists' professional practice.
4. Evaluate the effectiveness and reliability of iPhone applications in podiatry based on available scientific evidence.
5. Identify potential limitations and challenges associated with the use of iPhone applications in podiatry.
6. Provide a comprehensive scientific overview to guide healthcare practitioners in integrating iPhone applications into their clinical practice.
7. Contribute to the knowledge base in podiatry by critically evaluating the evidence and discussing practical implications.
8. Enhance assessment accuracy and treatment efficacy in podiatry through the use of iPhone applications.

Methods

The present scoping review was conducted following the JBI methodology [12] for scoping reviews. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) [13] Checklist for reporting was used. To support robust and clinically relevant results, the research team included authors with expertise in evidence synthesis, quantitative and qualitative research methodology, and sports and musculoskeletal rehabilitation. We formulated the following research question: "What is the potential of iPhone applications in podiatry clinical practice, and how do they impact the assessment, diagnosis, and treatment of foot conditions?" Studies were eligible for inclusion if they met the following Population, Concept, and Context (PCC) criteria.

Population

- Studies involving podiatrists, foot experts, or healthcare practitioners specializing in foot conditions.
- Studies involving patients with foot conditions or individuals seeking podiatric care.

Concept

- Studies focusing on the use of iPhone applications in the assessment, diagnosis, or treatment of foot conditions.
- Studies examining the effectiveness, reliability, or usability of iPhone applications in podiatry.

Context

- Studies conducted in clinical settings or real-world podiatric practice.
- Studies published in peer-reviewed journals or reputable conference proceedings.
- Studies published in the English language.
- Studies published within a specified time frame (if applicable).

Studies that did not meet the specific PCC criteria were excluded.

An initial limited search of MEDLINE was performed through the PubMed interface to identify articles on the topic and then the index terms used to describe the articles were used to develop a comprehensive search strategy for MEDLINE. The search strategy, which included all identified keywords and index terms, was adapted for use in Cochrane Central, Scopus, and PEDro. In addition, gray literature (e.g., Google Scholar, direct contacts with experts in the field) and reference lists of all relevant studies were also searched. Searches were conducted on April 23, 2023, with no date limitation. After completing the search strategy, the search results were collected and imported into EndNote V.X9 (Clarivate Analytics). To ensure the accuracy of the dataset, duplicates were removed using the EndNote deduplicator, resulting in a file containing a unique set of records. This file was then made available to the reviewers for further processing. The selection process involved two levels of screening using the Rayyan QCRI online software. At the first level, titled"title and abstract screening," two authors independently reviewed the articles based on their titles and abstracts. Any conflicts or discrepancies between the reviewers' decisions were resolved by a third author. The goal of this level was to assess the relevance of each article to the research question based on the provided information. The second level of screening, known as a "full-text selection," also involved two authors independently reviewing the full texts of the selected articles. The purpose of this level was to assess the eligibility of each article based on its complete content. Again, any conflicts or disagreements between the reviewers were resolved through discussion and, if necessary, consultation with a third author. Throughout the selection process, detailed records were maintained, documenting the reasons for excluding articles that did not meet the inclusion criteria. This documentation followed the latest published version of the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA 2020) flow diagram. The PRISMA flow diagram visually represents the screening process, indicating the number of articles identified, screened, assessed for eligibility, and included in the final analysis. By adhering to these rigorous selection procedures and reporting guidelines, transparency and reliability were ensured in the article selection process, enabling a comprehensive and systematic approach to be taken in the scoping review. Data extraction was conducted using a pre-designed data extraction form, specifically developed for this scoping review. The form was created based on the JBI (Joanna Briggs Institute) data extraction tool, tailored to capture key information from the selected articles. The extracted data included the following details: authors, country of publication, year of publication, study design, patient characteristics, pertinent findings or outcomes, type of intervention, related procedures, and any relevant additional information. Descriptive analyses were performed on the extracted data to summarize the characteristics of the included studies. The results were presented in a numerical format, using frequencies and percentages to report the studies identified and included in the scoping review. This approach allowed for a concise representation of the distribution and composition of the included studies. The description of the search decision process, including the number of articles identified, screened, assessed for eligibility, and ultimately included in the review, was systematically mapped. This mapping process provides transparency and clarity in documenting the selection process, allowing for a comprehensive understanding of the article selection flow. Importantly, the extracted data were summarized in tabular form, presenting the main characteristics of the included studies. These summary tables provide a structured overview of the key information extracted from each study, facilitating comparison and analysis of the findings across the included articles. Overall, the presentation of the extracted data in this scoping review primarily relies on concise and informative summary tables, providing a clear and organized representation of the main characteristics and results of the included studies.

Results

As presented in the PRISMA 2020-flow diagram (Fig. 1), from 37 records identified by the initial literature searches, 29 were excluded, and 8 articles were included (Tables 1 and 2). The quality of the studies was assessed using the QUADAS-2 [14] (Table 3).

Ege et al. 2013 [6]:

- *Aim:* Evaluate the accuracy of the Hallux Angles iPhone app in measuring hallux valgus angles.
- *Results:* The iPhone app demonstrated excellent concordance with computer-assisted measurements for hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA).
- *Conclusion:* The hallux angles iPhone app is a reliable and accurate tool for hallux valgus angle measurement.

Williams et al. 2013 [11]:

- *Aim:* Compare the reliability and validity of the TiltMeter iPhone app for measuring ankle range of motion (ROM) during the weight-bearing lunge test.
- *Results:* The TiltMeter app showed high reliability and good concurrent validity when compared to a digital inclinometer.
- *Conclusion:* The TiltMeter app is a reliable and cost-effective alternative for ankle ROM measurement in clinical practice.

Rasmussen et al. 2015 [8]:

- *Aim:* Assess the accuracy of a new portable imaging device (PID) versus the iPhone 4 s for telemedical use in evaluating foot ulcers.
- *Results:* The new PID exhibited higher agreement with clinical assessment compared to the iPhone 4 s.
- *Conclusion:* The new PID offers improved accuracy in telemedical ulcer assessment, enhancing ulcer treatment and care.

Aragón-Sánchez et al. 2017 [9]:

- *Aim:* Evaluate the reliability of using iPhone 6S photos analyzed with ImageJ software for measuring wound area in leg ulcers.
- *Results:* Excellent interrater and intrarater reliability were observed for wound area measurements using ImageJ software.
- *Conclusion:* Analyzing digital images with ImageJ software provides a reliable method for estimating wound area in clinical practice.

Romero Morales et al. 2017 [10]:

- *Aim:* Determine the validity and reliability of the Leg Motion device for measuring ankle dorsiflexion ROM in older adults.

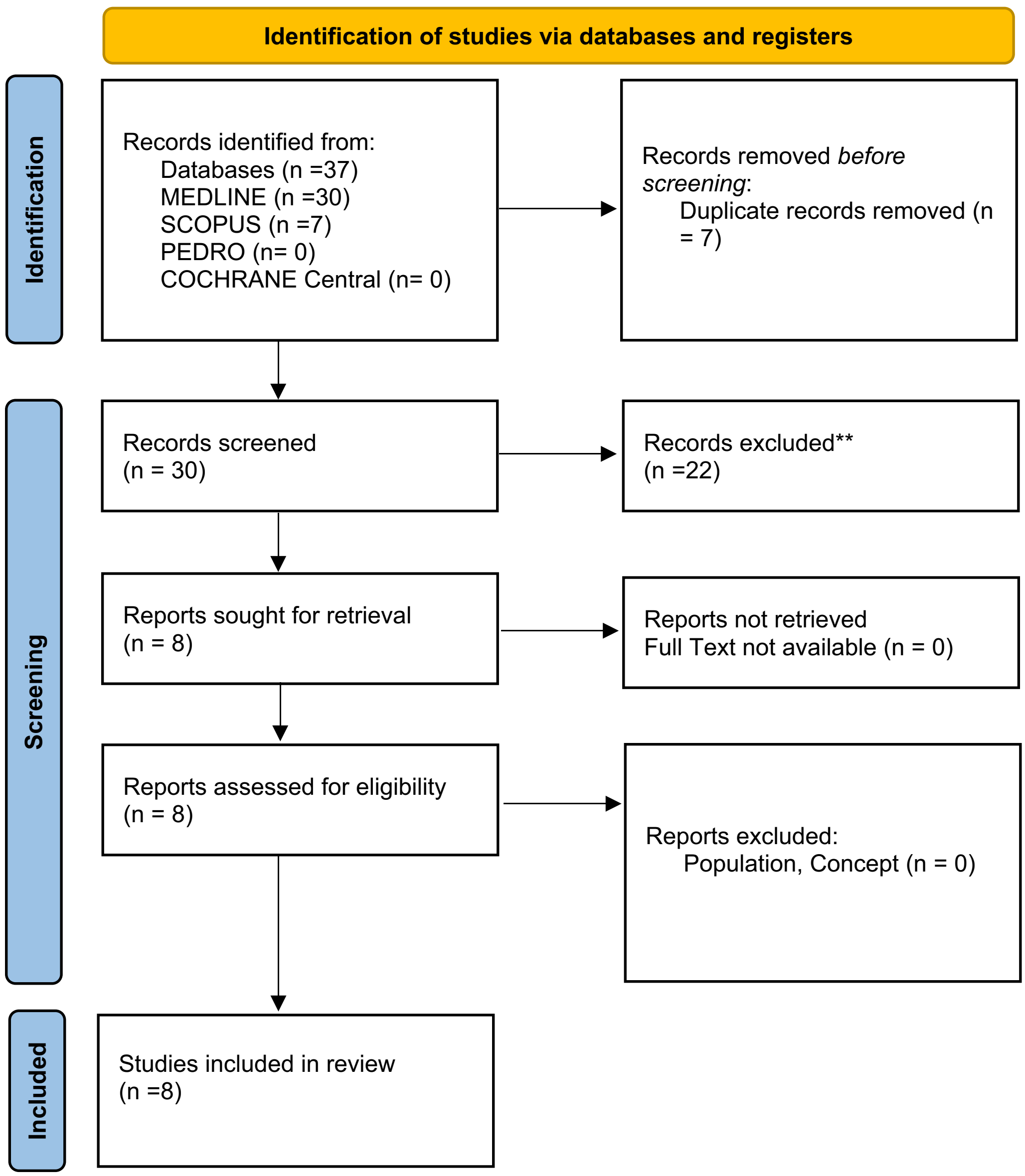

Fig. 1 Preferred reporting items for systematic reviews and meta-analyses 2020 (PRISMA) flow diagram

- *Results:* Leg Motion demonstrated good test–retest reliability and high agreement with other measurement tools.
- *Conclusion:* Leg Motion is a valid and reliable tool for assessing ankle dorsiflexion ROM in older adults.

Balsalobre-Fernández et al. 2019 [4]:

- *Aim:* Evaluate the reliability and validity of the iPhone Measure app for measuring ankle joint dorsiflexion in the weight-bearing lunge test.
- *Results:* The iPhone Measure app showed good to excellent reliability and excellent validity compared to a digital inclinometer.
- *Conclusion:* The iPhone Measure app is a reliable tool for assessing ankle joint dorsiflexion in healthy adults.

Banwell et al. 2019 [7]:

- *Aim:* Assess the validity and reliability of the Dorsiflex iPhone app for measuring weight-bearing ankle dorsiflexion.

Table 1 Main characteristics of included studies

N°	Author	Title	Year	Country	Study design
1	Ege et al. [6]	Use of the iPhone for radiographic evaluation of hallux valgus	2013	Turkey	Observational
2	Williams et al. [11]	The TiltMeter app is a novel and accurate measurement tool for the weight-bearing lunge test	2013	Australia	Observational
3	Rasmussen et al. [8]	Validation of a new imaging device for telemedical ulcer monitoring	2015	Denmark	Observational
4	Aragón-Sánchez et al. [9]	ImageJ: A Free, Easy, and Reliable Method to Measure Leg Ulcers Using Digital Pictures	2017	Spain	Observational
5	Romero Morales et al. [10]	The concurrent validity and reliability of the Leg Motion system for measuring ankle dorsiflexion range of motion in older adults	2017	Spain	Observational
6	BalsalobreFernández et al. [4]	Concurrent validity and reliability of an iPhone app for the measurement of ankle dorsiflexion and inter-limb asymmetries	2019	Spain	Observational
7	Banwell et al. [7]	The iPhone Measure app level function as a measuring device for the weight-bearing lunge test in adults: a reliability study	2019	Australia	Observational
8	Farhan et al. [5]	Comparison of multiple 3D scanners to capture foot, ankle, and lower leg morphology	2023	Australia	Observational

- *Results:* The Dorsiflex app exhibited strong correlation and agreement with a digital inclinometer.
- *Conclusion:* The Dorsiflex app offers a reliable and accurate method for measuring weight-bearing ankle dorsiflexion.

Farhan et al. 2023 [5]:

- *Aim:* Evaluate the accuracy and speed of various 3D scanners for capturing foot and ankle morphology for AFO fabrication.
- *Results:* The Artec Eva, Structure Sensor I, and Structure Sensor Mark II were identified as the most accurate and fastest 3D scanners.
- *Conclusion:* These scanners are suitable for capturing foot and ankle morphology for AFO fabrication.

Discussion

The increasing popularity and advancement of digital technologies have opened new perspectives in the field of clinical podiatry [15, 16]. In particular, the use of iPhones as measurement and assessment tools has garnered great interest and has demonstrated numerous advantages in various research contexts [4–9, 11]. By analyzing some recent studies, we can appreciate the progress and potential offered by these devices in the field of podiatry. One study evaluated the reliability of an iPhone application for measuring the hallux valgus angle, intermetatarsal angle, and distal metatarsal articular angle. The results showed good agreement between the measurements obtained with the iPhone and those obtained using computer-assisted digital techniques. This indicates that iPhones can provide accurate measurement of these parameters, enabling objective and reliable assessment of podiatric conditions. Another study compared the use of a digital inclinometer and an iPhone application for assessing ankle range of motion. Both the digital inclinometer and the iPhone application demonstrated good reliability, with intra- and inter-rater correlation coefficients exceeding 0.85 and 0.90, respectively. This suggests that iPhones can be used as valid tools for ankle range of motion assessment, offering a practical and cost-effective alternative to traditional instruments. Another promising area where iPhones have shown potential is in 3D scanning of the foot and ankle for orthotic fabrication. A study compared seven different 3D scanners, including iPhones, to evaluate the accuracy and speed in capturing foot and lower leg morphology. iPhones, particularly the Eva, SS I, and SS II models, emerged as the most accurate and fastest scanners, enabling the creation of high-quality orthotics. The use of iPhones in the clinical podiatry context offers numerous advantages. Firstly, these devices are easily accessible and widely available, making them convenient for podiatry professionals. Additionally, the applications and sensors integrated into iPhones allow for precise and reliable measurements, reducing dependence on specific and expensive instruments. iPhones also offer the ability to visually document podiatric conditions, such as through photography, simplifying communication between the professional and the patient. Despite the evident advantages, it is important to emphasize that the use of iPhones in clinical podiatry practice requires further studies and validations. Specific measurement protocols need to be developed and standardized, assessing the repeatability and reliability of measurements taken with iPhones and comparing the results with traditional methods. Furthermore, considerations regarding privacy and data security during the use of iPhones for clinical purposes are crucial [17, 18]. In conclusion,

Table 2 Types of interventions

Study	Population	Method	Outcome
Ege et al. [6]	32 patients with symptomatic hallux valgus Mean age: not present Follow-up not present	- Two observers - Measurements of hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMAA) using iPhone and computerized techniques - Computer-assisted digital angular measurements as reference standard	- Difference between iPhone and computerized measurements - Difference between first and second iPhone measurements for each observer - Inter- and intraobserver reliability of smartphone measurement method
Williams et al. [11]	20 health practitioners Mean age 40 (± 12) Follow-up not present	-Intra-rater reliability study - Two raters (novice and experienced)	- Comparison of digital inclinometer (DI) and TiltMeter app on an Apple iPhone for measuring ankle range of motion (ROM) - Evaluation of intra-rater and inter-rater reliability of DI and TiltMeter app - Measurement conducted in bent knee (BK) and straight leg (SL) positions - Concurrent validity established between DI and TiltMeter app
Rasmussen et al. [8]	36 individuals with foot ulcers Mean age: not present Follow-up not present	- Intra- and inter-individual variability study - Four specialists rated the ulcers and filled out a questionnaire	- Comparison of a new portable imaging device (PID) and iPhone 4 s for telemedical use in ulcer assessment - Evaluation of intra-rater and inter-rater agreement between PID and iPhone images compared to clinical assessment as the "gold standard"
Aragón-Sánchez et al. [9]	Set of 25 individuals with foot and leg ulcers Mean age: not present Follow-up not present	- Digital photographs taken with iPhone 6S - Four raters: head of the department, wound care nurse, physician, and medical student	- Evaluation of wound area measurement using digital photographs - Utilization of ImageJ 1.45 s freeware for visualizing and measuring wound area
Romero Morales et al. [10]	33 healthy elderly patients older than 65 years Mean age 71 (± 3.6) Follow-up not present	- Descriptive repeated-measures study - Evaluation of ankle dorsiflexion ROM using Leg Motion device, goniometer, tape measure, and smartphone with inclinometer app	- Assessment of the validity and reliability of the Leg Motion device for measuring ankle dorsiflexion range of motion (ROM) - Testing the reliability of Leg Motion device
Balsalobre Fernández et al. [4]	21 participants Mean age 28.6 (± 2.3) Follow-up not present	- Two experienced raters—iPhone level function (Measure app)—Digital inclinometer	- Intra-rater reliability: ICC > 0.85—Inter-rater reliability: ICC > 0.90—Concurrent validity: ICC = 1.0—Bland Altman plot validity: ICC = 0.84
Banwell et al. [7]	12 healthy participants (age = 28.6 ± 2.3 years) Mean age 22.9 (± 1.4) Follow-up not present	-Weight-bearing lunge test with each leg performed in five separate occasions -Comparison of 120 angles measured with the digital inclinometer and the Dorsiflex app	-Measurement of ankle dorsiflexion using a professional digital inclinometer and the Dorsiflex iPhone app -Validity, reliability, and accuracy analysis
Farhan et al. [5]	10 healthy participants Mean age 27.8 (± 9.3) Follow-up not present	Lower leg assessment using 7 3D scanners: Artec Eva (Eva), Structure Sensor (SS I), Structure Sensor Mark II (SS II), Sense 3D Scanner (Sense), Vorum Spectra (Spectra), Trnio 3D Scanner App on iPhone 11 (Trnio 11), and Trnio 3D Scanner App on iPhone 12 (Trnio 12)	- Mean accuracy ranged from 6.4 to 230.8% - SS I, SS II, and Eva had acceptable accuracy - Bland and Altman plots showed the smallest mean bias and LoA for Eva, SS I, and SS II - Mean speed ranged from 20.8 to 329.6 s - Eva, SS I, and SS II were identified as the most accurate and fastest 3D scanners for capturing foot, ankle, and lower leg morphology, suitable for AFO fabrication

Legend: *AFO* ankle–foot orthoses; *BK* bent knee; *DMAA*, distal metatarsal articular angle; *DI* digital inclinometer; *HVA* hallux valgus angle; *IMA* intermetatarsal angle; *PID* portable imaging device; *ROM* range of motion; *SL* straight leg; *SS I* structure sensor (version I); *SS II* structure sensor mark II

Table 3 Risk of bias

RISK OF BIAS				
	Selection of patients	Outpatient tests	Reference Standard	Timing
Ege T et al., 2013	Unclear	Low	unclear	Low
Williams CM et al., 2013	Low	Low	unclear	Low
Rasmussen BS et al., 2015	unclear	Low	unclear	Low
Aragón-Sánchez J et al., 2017	unclear	Low	unclear	Low
Romero Morales C et al., 2017	Low	unclear	unclear	Low
BalsalobreFernández C et al., 2019	Low	unclear	unclear	Low
Banwell HA et al., 2019	Low	unclear	unclear	Low
Farhan M et al., 2023	Low	Low	unclear	Low
low	5	5	0	8
High	0	0	0	0
unclear	3	3	10	0

ASSESSMENT OF APPLICABILITY			
	Selection of patients	Outpatient tests	Reference Standard
Ege T et al., 2013	Unclear	Low	unclear
Williams CM et al., 2013	Low	Low	unclear
Rasmussen BS et al., 2015	unclear	Low	unclear
Aragón-Sánchez J et al., 2017	unclear	Low	unclear
Romero Morales C et al., 2017	Low	unclear	unclear
BalsalobreFernández C et al., 2019	Low	unclear	unclear
Banwell HA et al., 2019	Low	unclear	unclear
Farhan M et al., 2023	Low	Low	unclear
Low	5	5	0
High	0	0	0
unclear	3	3	8

the use of iPhones in the clinical podiatry context offers numerous advantages in terms of accuracy, convenience, and ease of use. The studies conducted so far demonstrate the potential of these devices in the assessment and monitoring of podiatric conditions [19]. However, further research is needed to validate and optimize the use of iPhones as reliable clinical tools, in order to provide even more effective diagnostic and therapeutic support for podiatry professionals. The integration of iPhones into clinical podiatry practice offers several significant advantages for healthcare professionals, with the potential to transform patient care. These advantages include portability, imaging capabilities, measurement and assessment tools, telemedicine possibilities, data integration, and patient engagement. iPhones, being lightweight and portable, allow clinicians to access various podiatry applications and patient data conveniently during visits. The high-quality cameras enable the capture of visual documentation for condition tracking, consultations, and patient education. Specialized apps and accessories empower precise measurement and assessment of podiatric parameters, essential for diagnosis and treatment planning. iPhones facilitate telemedicine, making virtual consultations and remote monitoring feasible, particularly for patients facing access challenges. Seamless integration with electronic health records streamlines documentation, reduces errors, and supports data analysis for research and evidence-based decision-making. Additionally, iPhones provide tools for patient engagement and education, improving treatment adherence and satisfaction. However, it is important to acknowledge certain limitations, such as the need for careful attention to measurement accuracy, privacy and data security concerns, device limitations, and the necessity of operator training for proficient use.

Conclusions

This study underscores the substantial potential of iPhones in clinical podiatry. iPhones offer precise measurements, telemedicine capabilities, and improved patient engagement tools. However, to fully harness their benefits, it is essential to address issues related to validity, standardization, and data security. In summary, iPhones hold promise for enhancing podiatric care, increasing efficiency, and ultimately benefiting patients.

Abbreviations

AFO Ankle-foot orthosis
CV Coefficient of variation
DI Digital inclinometer
DI Digital inclinometer
DMAA Distal metatarsal articular angle
HVA Hallux valgus angle
ICC Intra-class correlation coefficient

IMA	Intermetatarsal angle
LoA	Limit of agreement
ROM	Range of motion
SD	Standard deviation
SS I	Structure sensor
SS II	Structure sensor mark II
Trnio 11	Trnio 3D scanner app on iPhone 11
Trnio 12	Trnio 3D scanner app on iPhone 12

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References
1. Bennell KL, Talbot RC, Wajswelner H, Techovanich W, Kelly DH, Hall AJ (1998) Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. Aust J Physiother 44(3):175–180
2. Bohannon RW, Smith MB (1987) Interrater reliability of a modified Ashworth scale of muscle spasticity. Phys Ther 67(2):206–207
3. Calatayud J, Martin F, Gargallo P, García-Redondo J, Colado JC, Marín PJ (2015) The validity and reliability of a new instrumented device for measuring ankle dorsiflexion range of motion. Int J Sports Phys Ther 10(2):197–202
4. Balsalobre-Fernández C, Romero-Franco N, Jiménez-Reyes P (2019) Concurrent validity and reliability of an iPhone app for the measurement of ankle dorsiflexion and inter-limb asymmetries. J Sports Sci 37(3):249–253
5. Farhan M, Wang JZ, Lillia J, Cheng TL, Burns J (2023) Comparison of multiple 3D scanners to capture foot, ankle, and lower leg morphology. Prosthet Orthot Int 47(6):625–632. https://doi.org/10.1097/PXR.0000000000000230. (Epub 2023 Mar 16)
6. Ege T, Kose O, Koca K, Demiralp B, Basbozkurt M (2013) Use of the iPhone for radiographic evaluation of hallux valgus. Skeletal Radiol 42(2):269–273
7. Banwell HA, Uden H, Marshall N, Altmann C, Williams CM (2019) The iPhone Measure app level function as a measuring device for the weight bearing lunge test in adults: a reliability study. J Foot Ankle Res 12:37
8. Rasmussen BSB, Froekjaer J, Joergensen LB, Halekoh U, Yderstraede KB (2015) Validation of a new imaging device for telemedical ulcer monitoring. Skin Res Technol 21(4):485–492
9. Aragón-Sánchez J, Quintana-Marrero Y, Aragón-Hernández C, Hernández-Herero MJ (2017) ImageJ: a free, easy, and reliable method to measure leg ulcers using digital pictures. Int J Low Extrem Wounds 16(4):269–273
10. Romero Morales C, Calvo Lobo C, Rodríguez Sanz D, Sanz Corbalán I, Ruiz Ruiz B, López LD (2017) The concurrent validity and reliability of the Leg Motion system for measuring ankle dorsiflexion range of motion in older adults. PeerJ 5:e2820
11. Williams CM, Caserta AJ, Haines TP (2013) The TiltMeter app is a novel and accurate measurement tool for the weight bearing lunge test. J Sci Med Sport 16(5):392–395
12. Peters: Joanna Briggs Institute Reviewer's Manual, JBI - Google Scholar. [cited 2022 Jun 9]. Available from: https://scholar-google-com.ezproxy.unibo.it/scholar_lookup?hl=en&publication_year=2020&author=MDJ+Peters&author=C+Godfrey&author=P+McInerney&author=Z+Munn&author=AC+Tricco&author=H+Khalil&title=Joanna+Briggs+Institute+Reviewer%27s+Manual%2C+JBI
13. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D et al (2018) PRISMA Extension for Scoping Reviews (PRISMA-ScR): checklist and explanation. Ann Intern Med 169(7):467–473
14. Whiting PF, Rutjes AWS, Westwood ME, Mallett S, Deeks JJ, Reitsma JB et al (2011) QUADAS-2: a revised tool for the quality assessment of diagnostic accuracy studies. Ann Intern Med 155(8):529–536
15. Pc C, Bf M, Yh P, Ra C. Reliability and concurrent validity of a Smartphone, bubble inclinometer and motion analysis system for measurement of hip joint range of motion. Journal of science and medicine in sport. 2015 May [cited 2023 Jun 4];18(3). Available from: https://pubmed.ncbi.nlm.nih.gov/24831757/
16. Peart DJ, Balsalobre-Fernández C, Shaw MP (2019) Use of mobile applications to collect data in sport, health, and exercise science: a narrative review. J Strength Cond Res 33(4):1167–1177
17. Sl V, Ar B, J B, Ce H, Ej N. Reliability and validity of a smartphone app to measure joint range. American journal of physical medicine & rehabilitation. 2015;94(4). Available from: https://pubmed.ncbi.nlm.nih.gov/25299533/
18. Akinyemi KO, Atapu AD, Adetona OO, Coker AO (2009) The potential role of mobile phones in the spread of bacterial infections. J Infect Dev Ctries 3(8):628–632
19. Milani P, Coccetta CA, Rabini A, Sciarra T, Massazza G, Ferriero G (2014) Mobile smartphone applications for body position measurement in rehabilitation: a review of goniometric tools. PM R 6(11):1038–1043

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