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Patient needs, functional requirements, aesthetic preferences and barriers in app-based therapy for knee osteoarthritis

Potrzeby pacjentów, wymagania funkcjonalne, preferencje estetyczne i bariery w terapii opartej na aplikacjach w przypadku choroby zwyrodnieniowej stawu kolanowego

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STRESZCZENIE

POTRZEBY PACJENTÓW, WYMAGANIA FUNKCJONALNE, PREFERENCJE ESTETYCZNE I BARIERY W TERAPII OPARTEJ NA APLIKACJACH W PRZYPADKU CHOROBY ZWYRODNIENIOWEJ STAWU KOLANOWEGO

Wprowadzenie. Choroba zwyrodnieniowa stawu kolanowego (KOA) to stan zapalny, na który cierpi ponad 25% dorosłych. Technologia internetowa/mobilna oferuje potencjalne korzyści w leczeniu KOA, poprawiając dostęp do opieki i obniżając koszty poprzez wykorzystanie urządzeń mobilnych w opiece medycznej i edukacji pacjentów.

Cel pracy. Celem badania jest odpowiedź na pytanie, jakie potrzeby, wymagania funkcjonalne i preferencje estetyczne mają pacjenci z chorobą zwyrodnieniową stawu kolanowego oraz jakie bariery i ułatwienia napotykają podczas korzystania z terapii opartej na aplikacji.

Materiał i metody. Zastosowaliśmy jakościowy projekt badawczy obejmujący wywiady pogłębione z 20 pacjentami.

Wyniki i wnioski. Rozmówcy podkreślali, że skuteczne aplikacje do zarządzania KOA muszą odpowiadać różnorodnym potrzebom pacjentów, zapewniać dostępność, oferować konfigurowalne funkcje, zapewniać kompleksowe informacje i narzędzia do samodzielnego zarządzania, wspierać łagodzenie bólu, umożliwiać zdalne monitorowanie, integrować się ze społecznościami wsparcia i być opłacalne. Aplikacje te powinny łączyć wymagania funkcjonalne – takie jak prosty interfejs użytkownika, integracja z urządzeniami do noszenia, treści edukacyjne, wskazówki dotyczące ćwiczeń, narzędzia do leczenia bólu, zdalne konsultacje, wsparcie społeczności i mechanizmy informacji zwrotnej – z preferencjami estetycznymi w zakresie przejrzystego, przystępnego projektu i dużych czcionek, kolory o wysokim kontraście, odpowiednie elementy interaktywne, spójny układ, animacje prowadzące i funkcje ułatwień dostępu, takie jak zmiana rozmiaru tekstu, polecenia głosowe i opisy audio. Podsumowując, badanie to podkreśla konieczność integrowania przez aplikacje do zarządzania KOA różnorodnych wymagań funkcjonalnych i preferencji estetycznych, zapewniania dostępności, dostosowywania, kompleksowych informacji i funkcji wsparcia w celu zwiększenia użyteczności, skuteczności i zadowolenia pacjentów.

Słowa kluczowe: spostrzeżenia, pacjenci, zastosowanie, fizjoterapia, choroba zwyrodnieniowa stawu kolanowego

ABSTRACT

PATIENT NEEDS, FUNCTIONAL REQUIREMENTS, AESTHETIC PREFERENCES AND BARRIERS IN APP-BASED THERAPY FOR KNEE OSTEOARTHRITIS

Introduction. Knee osteoarthritis (KOA) is an inflammatory condition affecting over 25% of adults. Web/mobile technology offers potential benefits in the treatment of KOA by improving access to care and reducing costs by utilising mobile devices for medical care and patient education.

Aim. The study aims to answer the question of what needs, functional requirements and aesthetic preferences patients with knee osteoarthritis have and what barriers and facilitators there are when using an app-based therapy.

Material and methods. We used a qualitative research design with in-depth interviews with 20 patients.

Results and conclusion. Interviewees emphasized that effective KOA management apps must address diverse patient needs, ensure accessibility, offer customizable features, provide comprehensive information and self-management tools, support pain relief, enable remote monitoring, integrate with support communities, and be cost-efficient. These apps should combine functional requirements, such as a simple user interface, integration with wearable devices, educational content, exercise guidance, pain management tools, remote consultations, community support, and feedback mechanisms, with aesthetic preferences for clear, accessible design, large fonts, high-contrast colours, suitable interactive elements, consistent layout, guiding animations, and accessibility features like text resizing, voice commands, and audio descriptions. In conclusion, this study underscores the necessity for KOA management apps to integrate diverse functional requirements and aesthetic preferences, ensuring accessibility, customization, comprehensive information, and support features to enhance usability, effectiveness, and patient satisfaction.

Key words: perceptions, patients, application, physiotherapy, knee osteoarthritis

INTRODUCTION

Over 25% of adults suffer from knee osteoarthritis (KOA), an inflammatory condition that significantly impairs life quality and imposes a growing economic and health burden globally [1]. Mobile health technology offers potential advantages in KOA management by improving access to care and reducing costs [2], leveraging mobile devices to deliver medical care and patient education. Despite existing barriers, such as limited healthcare access and professional time constraints, mobile apps facilitate self-management and adherence to clinical guidelines [3].

Choi et al. [4] conducted a systematic review of mobile apps for self-management of KOA and concluded that these apps are primarily used for patient education but lack robust empirical support. They recommended that future apps should integrate features such as self-management, decision support, and collaborative decision-making. Similarly, a systematic review and meta-analysis by Safari et al. [5] evaluated digital self-management interventions for KOA delivered via various platforms, such as mobile apps, the internet, and audiovisual methods. They reported moderate evidence demonstrating small to moderate improvements in pain and function sustained over one year. McHugh et al. [6] reviewed randomised trials of the effectiveness of remote exercise programmes for KOA and found significant benefits when interventions included proactive follow-up by healthcare providers and behaviour change counselling. Shah et al. [7] evaluated the effectiveness and cost-effectiveness of digital health technologies—from mobile apps to social media in the treatment of KOA using a narrative review. Their findings suggest that digital interventions, particularly those involving cognitive behavioural therapy, are as effective as traditional treatments in improving outcomes for KOA patients. These studies emphasise the need to incorporate user preferences and contextual patient factors into the design of future digital health interventions to improve efficacy and acceptability. Comprehensive reviews suggest that digital interventions, particularly those including cognitive behavioural therapy, effectively improve outcomes in KOA by enabling remote monitoring and behavioural interventions.

One major issue with current mobile apps for KOA is their low user retention, often not exceeding 90 days, attributed to the development and implementation methods used [4]. Involving users in the app design process is crucial to address this problem, ensuring their preferences, needs, and aesthetic considerations are met [9]. Qualitative studies indicate that while patients generally support these apps, physicians express concerns over patient accountability. This disparity suggests the need for a co-design approach to develop apps that meet the expectations of both patients and physicians. Such collaboration was found to prioritize features like visual symptom tracking, goal setting, exercise planning, daily activity monitoring, and self-management strategies [10]. The sole study quantifying attitudes towards mobile health intervention design by Biebl et al. [11] surveyed 127 German healthcare professionals and revealed strong support for app-based therapy for KAO, highlighting significant potential. The content, such as educational units, physiotherapy exercises, and motivational psychology, was broadly favoured, with consensus on the need for a multimodal therapy approach.

Given the existing lack of detailed research on patients' needs regarding app-based therapy for KOA and the essential features that web/mobile apps should include, our aim is to fill this research gap and to answer the question of what needs, functional requirements and aesthetic preferences patients with knee osteoarthritis have and what barriers and facilitators there are when using an app-based therapy.

MATERIALS AND METHODS

This study employed a qualitative research design using in-depth interviews to investigate the needs, functional requirements, and aesthetic preferences of patients regarding app-based therapy for KOA.

A purposive, heterogeneous sample of 20 individuals diagnosed with KOA was selected to capture a broad range of demographic characteristics and experiences. Participants were selected to be variable in terms of age, gender, ethnicity, socioeconomic status, and severity of KOA. This approach was intended to provide a comprehensive understanding of the different impacts and experiences associated with KOA in different populations. The age of participants ranged from 40 to 75 years, with a mean age of 58.5 years (SD = 10.2). The sample comprised 12 women and 8 men. Socioeconomic status was assessed by income level, with participants distributed across low (30%), middle (50%), and high (20%) income groups. The severity of KOA was determined using the Kellgren-Lawrence scale, with participants representing all four grades:

grade 1 (10%), grade 2 (35%), grade 3 (40%), and grade 4 (15%). This split ensured that people at different stages of the disease, from early to advanced KOA, participated. A total of 20 interviews were conducted in March and April 2024. Patients included in the study met inclusion criteria that required direct experience with KOA treatment. The semi-structured interviews were designed to align with the research objectives: (1) to explore the specific needs of KOA patients, (2) to identify the functional requirements and aesthetic preferences for the app, and (3) to identify the barriers and facilitators associated with using the app. The interview guide was structured as follows: 1. Introduction and background: collect demographic information, general health status, and KOA history to contextualise individual needs (e.g., „Can you describe your first KOA diagnosis and its impact on your daily life?"), 2: explore the specific needs of KOA patients, focusing on daily challenges and support systems (e.g., „What are your most pressing needs related to managing KOA?"), 3. Functional and aesthetic preferences: Identify what participants would you like to see in terms of app functionality and design (e.g., „What features would you find most useful in an app for managing KOA, and what should the app look and feel like?"), 4. Discuss potential barriers and supports to app use (e.g., „What might prevent you from using an app for KOA, and what would encourage its use?").

The interviews were conducted in locations that ensured confidentiality and comfort, such as private rooms in medical facilities, or other agreed-upon locations. Each interview lasted between 45 and 90 minutes.

All interviews were recorded with the consent of the participants using a high-quality digital recording device. An expert transcription service accurately and completely transcribed the recordings. To maintain confidentiality, the transcripts were assigned unique codes and anonymized to eliminate any identifying information.

The study procedures adhered to strict formal research rules and ethical standards. Ethical approval was granted by the Commission for Medicine Ethics of the Republic of Slovenia (No. 0120-471/2023-2711-4) and is part of the project "Usefulness, effectiveness, and satisfaction with a web-based integrated clinical pathway for patients with knee cartilage defects focusing on an online exercise programme" (No. L7-50184), which is co-financed by the Slovenian Research and Innovative Agency and Artros.

To increase the trustworthiness and credibility of the results, we employed triangulation by integrating multiple data sources (e.g., medical records), maintaining reflexivity through reflection by different project members to minimise bias, conducting an independent audit by different project members to verify the accuracy and reliability of the data analysis, and undertaking participant verification by reviewing and validating the preliminary findings to ensure that the qualitative data collected was robust and accurately reflected KOA patients' needs, preferences, and challenges in using the app.

The thematic analysis for this study was conducted following the six-phase framework developed by Braun and Clarke [12], ensuring a systematic and rigorous examination of the qualitative data. The process began with familiarization, where authors immersed themselves in the data by repeatedly reading the transcripts and noting initial ideas. This was followed by generating initial codes, where key features of the data were identified and systematically coded across the entire dataset, culminating in a comprehensive list of codes. In the third phase, these codes were organized into potential themes, gathering all relevant data for each theme. The reviewing themes phase involved checking the themes against the coded data and the entire dataset to ensure they accurately reflected the data, with necessary refinements for coherence and consistency. Subsequently, each theme was further refined and clearly defined in the defining and naming themes phase, with detailed analyses written to define the scope and focus of each theme. Finally, the producing the report phase synthesized the final themes into a coherent and compelling narrative, connecting back to the research questions and relevant literature.

RESULTS

Interviewees pointed out that the development of apps for the management of KOA must address the different needs of patients to be effective and widely accepted (Tab. 1.). The app must be accessible to all users, including those with limited technical abilities or physical limitations. Customising features for individual conditions and preferences increases engagement. Patients need comprehensive and understandable information about the disease, self-management tools to monitor symptoms and activities, and support with pain relief. The application should also enable remote monitoring by healthcare professionals and easy communication. Integration with support communities to share experiences is important. Motivational features and cost-efficiency ensure regular use and accessibility of the app for all. Meeting these requirements contributes to the development of a patient-centred application, which increases its usability, effectiveness, and user satisfaction

To effectively support KOA patients, a mobile app should combine specific functional requirements and aesthetic preferences tailored to their needs (Tab. 2.). Functional requirements, according to interviewees, include a simple user interface, customisation options, integration with wearable devices, and data tracking and reporting features. The app should also provide educational content about KOA, exercise guidance, pain management tools, remote consultation options, community support features, and a feedback mechanism for continuous improvement. Aesthetic preferences include a clear, accessible visual design with large fonts and high-contrast colours, interactive elements suitable for users with varying dexterity, a consistent layout throughout the app, and animations that help guide without overwhelming. Accessibility should be a priority, with features such as text resizing, voice commands and audio descriptions to suit all users.

Interviewees discussed the barriers and facilitators associated with using mobile apps to manage KOA (Tab. 3.). Key barriers include technological knowledge, app design

issues, health literacy, privacy concerns, physical limitations, and cost. These challenges can impact user engagement and the effectiveness of the app. In contrast, factors that encourage app use include personalised features tailored to individual needs, user-friendly interfaces, integration with health systems for real-time support, education, and engagement tools to improve health literacy and motivation, evidence-based content that ensures reliability, and cost-effective solutions that provide value for money. Removing these barriers and leveraging facilitators can significantly improve the uptake and impact of mobile health apps for patients with KOA, ultimately improving disease management and quality of life.

Tab. 1. Thematic analysis with sub-themes and codes and patient quotes on their specific needs in relation to app-based therapy for KOA

Themes	Subtheme	Codes	Quotes
The needs of patients in relation to app-based therapy for KOA	Accessibility	Easy to use for all patients	*It should be easy to use for me, as I have limited technological knowledge* … (Patient 13)
	Customization	Customize settings such as exercise routines, pain management plans	*We should be able to adjust the settings to … adjust the use*. (Patient 2)
	Self-management tools	Tools for tracking symptoms, pain levels, medication adherence, and physical activity	*It would help me a lot if the app could record my progress, you know everything* … (Patient 4)
	Comprehensive information	Detailed, reliable, and easily understandable information	*I think, we need clear, basic info about KOA*. (Patient 3)
	Exercise guidance	Video demonstrations	*It should offer exercise programs that match mine specific condition* ... (Patient 5)
	Remote monitoring and feedback	Capability for physiotherapists to monitor patients' progress remotely and provide feedback	*Physiotherapists can keep an eye on patients' progress and give feedback*. (Patient 6)
	Communication	Communication between patients and physiotherapists for consultations, doubt clarification, and motivation	*Make sure it's super easy for patients to chat with their physiotherapists*. (Patient 7)
	Motivational features	Incorporation of motivational reminders	*It should have motivational reminders to help me stick to my exercise routines*. (Patient 8)
	Cost-Effectiveness	Accessible to all patients, regardless of their financial situation	*To put simple, it should be free*. (Patient 9)

Tab. 2. Thematic analysis with sub-themes and codes and KOA patients quotes on the functional requirements and aesthetic preferences for the app

Themes	Subtheme	Codes	Quotes
Functional requirements	User interface simplicity	Easy-to-navigate interface	*Ease of use is important because we are mostly older people*. (Patient 8)
	Personalization	Customize settings such as exercise routines, pain management plans	*As I said earlier, flexibility is important*. (Patient 16)
	Data tracking and reporting	Data analysis to track progress over time	*It is also important to record things*. (Patient 14)
	Educational content	Comprehensive resources on KOA including management techniques, nutritional advice, and lifestyle modifications	*I think it is important that it also includes educational support, such as basic information*. (Patient 13)
	Exercise guides and plans	Tailored tutorials	*It should include step-by-step exercise tutorials* … (Patient 16)
	Remote consultations	Virtual communication	*It must allow virtual communication with physiotherapists*. (Patient 17)
Aesthetic preferences	Visual design	Easy readability	*Clean, clutter-free design with large, readable fonts and high-contrast colour schemes*. (Patient 16)
	Interactive elements	User-friendly touch	*User-friendly touch controls with responsive design elements*. (Patient 4)
	Animations and visual cues	Subtle animations, icons, or colour changes	*We'll add some gentle animations to help guide you through the app*. (Patient 9)

Tab. 3. Thematic analysis with sub-themes and codes and KOA patients quotes on the barriers and facilitators related to the use of such an app

Themes	Subtheme	Codes	Quotes
Barriers of using the app	Technological literacy and accessibility	•Lack of technological skills •Reliable internet	*Some folks with KOA might not be too tech-savvy*. (Patient 3)
	Physical limitations	Limited physical activity	*Pain can limit me from making the physical activity*. (Patient 16)
	Motivation	Weak motivation	*I'm afraid that I won't be able to do it if there is no external pressure*. (Patient 15)
Facilitators of using the app	Personalization and freedom	Customizing the app to individual patient profiles	*It is important for me to be able to define time and space. That's freedom for me*. (Patient 6)
	Cost-effectiveness	Offering free core features	*It's also good that it's free*. (Patient 14)
	Integrated health support	Incorporating virtual consultations or reminders for medication and exercises	*Since physiotherapists don't have time, it's great to be able to function with them when it suits me*. (Patient 19)

DISCUSSION AND CONCLUSION

When developing mobile apps for the treatment of knee osteoarthritis (KOA), it is crucial to consider the diverse needs of patients to increase the effectiveness and acceptance of these digital tools. This study builds on existing research aimed at bridging the gap in understanding the specific needs, functional requirements, and aesthetic preferences of KOA patients, as well as identifying barriers and facilitators to the use of such apps. The findings from this study align with the broader literature, which emphasizes the importance of user-centered design in healthcare technology. Previous studies, such as those by Zayim, Yıldız and Yüce [13], highlight that the effectiveness of health apps is significantly enhanced when they are tailored to the specific needs and capabilities of the target user group. Our study adds to this body of knowledge by detailing the necessity for KOA apps to be accessible to users with limited technical abilities or physical disabilities, thereby broadening their usability across a more diverse patient population. Customization emerged as a critical factor in increasing patient engagement, echoing findings from systematic review by Bombard et al. [14], which demonstrated that personalization in health apps leads to higher user engagement and satisfaction. Interviewees in our study stressed that features tailored to individual conditions and preferences are essential for maintaining user interest and compliance. Moreover, the inclusion of comprehensive, understandable information about KOA, self-management tools to monitor symptoms and activities, and support for pain relief were identified as fundamental components of effective KOA apps. This is consistent with studies by Lorig et al. [15], which showed that self-management education improves health outcomes in chronic disease patients. Furthermore, the integration of features for remote monitoring by healthcare professionals and easy communication channels can enhance the continuum of care, as supported by research from Chiauzzi et al. [16]. Incorporating motivational elements and ensuring cost-efficiency are also crucial for encouraging regular use and making the app accessible to all users. This aligns with the findings of Krebs and Duncan [17], who found that motivation and cost are significant factors influencing the sustained use of health apps. A user-centered design approach, which increases an app's usability, effectiveness, and user satisfaction, is therefore paramount. To effectively support KOA patients, apps must consider certain functional requirements and aesthetic preferences. Key functional requirements identified in this study include a simple user interface, customization options, integration of wearable technology for data tracking, and features for KOA education, exercise guidance, pain management, remote consultations, community engagement, and continuous feedback for improvement. These findings are consistent with the principles of user-centered design outlined by Norman and Draper [18], which advocate for the design of interfaces that are easy to learn and use. Aesthetically, the app should have a clean, accessible design with large fonts, high-contrast colours, appropriate interactive elements, and a consistent layout, supported by animations that guide the user without overwhelming them. Accessibility features, such as text resizing, voice commands, and audio descriptions, are crucial to meeting all user needs, a sentiment that resonates with the guidelines provided by the World Health Organization [19] on designing inclusive health applications.

Barriers such as technological knowledge, design flaws, health literacy, physical limitations, and cost must all be considered. Conversely, the use of tools such as personalized features, user-friendly interfaces, real-time integration of health systems, educational tools, evidence-based content, and cost-effective solutions can significantly improve the adoption and impact of KOA management apps, thereby enhancing overall disease management and quality of life. A comparison with other studies shows that the results are similar [4-11], except for one point, namely that our interviewees did not mention ensuring data security and privacy as a key element of app-based therapy. This could be since patients prefer the immediate benefits of using health apps, as the waiting time for physiotherapy is at least two months, according to web page https://cakalnedobe.ezdrav.si/.

What are the recommendations and implications of the results? When developing mobile apps for the treatment of KOA, the different needs of patients should be prioritised to improve effectiveness and acceptance. Building on existing research, this study highlights several key recommendations for app developers and healthcare providers. Apps must meet key functional requirements, such as a simple, intuitive user interface, customisation options for individual conditions and preferences, and seamless integration with wearable devices for real-time data tracking and monitoring. They should provide comprehensive and understandable educational content about KOA, self-management tools for monitoring symptoms and activities, and features for remote consultations and communication with healthcare professionals. Support for community engagement and mechanisms for continuous feedback and improvement are also important. Aesthetically, the app should have a clear, accessible design with large fonts, high-contrast colours, and a consistent layout, with appropriate interactive elements and guiding animations. Accessibility features, such as text resizing, voice commands, and audio descriptions, are crucial. Developers need to address potential barriers, including technological knowledge, design flaws, health literacy, physical limitations, and cost. Personalised features, real-time integration with healthcare systems, educational tools, and cost-effective solutions can significantly improve the uptake and impact of apps. While this study is consistent with existing literature, it found that ensuring data security and privacy was not considered critical by respondents. This is likely due to the immediate benefits perceived using health apps, particularly given the long waiting times for physiotherapy, which can exceed two months. Applying a user-centred design approach that emphasises ease of use, customisation, accessibility, and cost-effectiveness is likely to lead to higher user satisfaction, better disease management, and an improved quality of life for KOA patients.

Despite its rigorous methodology, this study has some limitations. The sample size of 20 participants, while purposive and heterogeneous, may not fully reflect the diversity of all people's experiences with KOA. In addition, the use of self-report may lead to recall bias or subjective interpretations of symptoms and experiences. The geographic and cultural background of participants may also have an impact on the results, limiting their generalizability to other populations. Lastly, even though measures like reflexivity, independent verification, member checking, and triangulation have been implemented to guarantee the validity and reliability of qualitative data, there are still inherent limitations to qualitative research, like the possibility of researcher bias. Future research should consider larger and more diverse samples, as well as longitudinal studies, to further validate and extend these findings.

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