Mobile App Use among Chronic Pain Patients

A Gamified Approach

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***Abstract*— Chronic pain, which affects more than 30% of adults in Portugal, requires a multidisciplinary therapeutic approach. To stabilize or minimize the patient's pain, it is essential that patients comply with the prescribed treatments, not only pharmacological but also regarding physical activity. The assessment of the patient's condition, regarding the level of pain and their general physical condition, when carried out only in a consultation context, is not always reliably expressed by the patient. This study explores the potential of a mobile application in chronic pain management, with a focus on fibromyalgia. FisioQuest uses gamification to increase patient engagement and treatment adherence, including continuous symptom monitoring, physical exercise and cognitive-behavioral therapy. This application is based on preliminary studies that have shown significant improvements in pain severity, anxiety and depression among fibromyalgia patients who use mobile applications. This article details the requirements, specifications and use cases of the FisioQuest app, highlighting its potential benefits and future directions. It is hoped that, when validated, the FisioQuest app can offer an effective tool for improving patients' self-management and quality of life in the treatment of chronic pain.**

Keywords - chronic pain; fibromyalgia syndrome; mobile app; gamification.

I. INTRODUCTION

Chronic primary pain is defined by the International Association for the Study of Pain as pain in one or more anatomical regions that [1] persists or recurs for more than 3 months and is associated with significant emotional distress (e.g., anxiety, anger, frustration, or depressed mood) or significant functional disability (interference in activities of daily life and participation in social roles), and the symptoms are not better accounted for by another diagnosis [2].

Chronic pain causes significant physical and emotional repercussions for the patient, as well as socio-economic consequences with extended periods of work absenteeism. Consequently, it has a huge negative effect on the lives of patients and their families, as well as having an important economic impact on society [13]-[16]. In Portugal, its prevalence exceeds 30% in the adult population [3].

The limited efficacy of pharmacotherapy in treating chronic pain and the long-term side effects of these pharmacological treatment options [2][4][5] motivate the search for new techniques and therapeutic approaches.

Among the non-pharmacological measures, which the guidelines emphasize should be the foundation of the therapeutic approach to chronic pain [3], are, among others, physical exercise, patient education about their condition, and psychotherapeutic intervention through Cognitive-Behavioral Therapies (CBT), the latter being cited as having a strong level of evidence by the American Society of Anesthesiologists [3].

Currently, technology influences all facets of modern society and is set to revolutionize healthcare in the future. The use of new technologies is growing in health communication for health promotion, disease prevention and health care delivery [6]. The COVID-19 pandemic has expedited the digitization of healthcare, fostering the development and implementation of telehealth methodologies, including remote medical consultations, home hospitalization, and remote monitoring of vital signs.

The global trend of increasing information and communication technology usage in healthcare enhances public health and well-being. These technologies have taken various forms, such as software applications, mobile apps, digital sensors, immersive virtual reality equipment, and other therapeutic interventions.

With the substantial rise in mobile device usage in recent years, mobile application-based treatment options have become increasingly prevalent. While the empirical validation of such app-based programs is still pending [4], they hold potential for empowering patients to independently manage their pain, thereby reducing the likelihood of relapse.

A recent systematic review and meta-analysis on mobile application-based interventions for chronic pain patients has been published [4]. The final sample comprised twenty-two studies, with a total of 4679 individuals. The results suggest that apps-based treatment can be helpful in reducing pain, especially in the long-term [4]. Thus, we understand that mobile applications can be a powerful tool to assist patients and healthcare professionals in the approach and treatment of Chronic Pain. This can be achieved through better perception of pain evolution throughout the day, the effect of medications and their side effects, the impact of the disease on daily living activities and the patient's professional life, sleep quality, and physical exercise performance. In addition

to potentially improving the patient's quality of life, it allows for the optimization of communication and the relationship between doctor and patient, with evident benefits for all.

Fibromyalgia Syndrome (FMS) is a rheumatic disorder characterized by chronic widespread pain often associated with fatigue unrefreshed sleep and cognitive difficulties [6][7]. FMS is a common syndrome in the general population, reaching a prevalence of 2–3% worldwide [8]. It is a debilitating condition that impairs quality of life, increases health care utilization, impairs work productivity and daily activities [6].

Despite the acquired perception regarding the importance of mobile applications in assisting patients in managing their illness, little is known about persons with fibromyalgia use mobile apps for health-related purposes [6]. Demonstrating the relevance of the topic, in the last decade, we have observed the development of mobile applications specifically for patients with fibromyalgia, such as Fibroline [9] and Profibro [10]. Studies have been published analyzing the outcomes of using these applications in promoting self-care, monitoring symptoms, and improving quality of life [9][10].

A cross-sectional survey was recently published, analyzing the use of mobile apps among persons with fibromyalgia [11], concluding that approximately two-thirds of the sample used mobile apps. The results showed that ease of use and the fact that the apps were free were essential factors for their utilization.

On the other hand, reasons for discontinuing use included issues with privacy, the effort required, lack of interest, and lack of perceived quality [11]. Other reasons for app nonuse were lack of awareness and lack of knowledge on how to use them, indicating that disseminating information about apps and addressing other barriers, such as providing user support, are critical to increasing uptake [11].

Miro et al. [12] published a preliminary evaluation of a mobile-app-delivered, Cognitive Behavioral Treatment (CBT)-based intervention in helping adults self-manage fibromyalgia symptoms. The study included a total of 100 adults with FMS which were given access to the digital treatment program and downloaded the app. Pain severity, anxiety symptoms, depression symptoms, fatigue, and sleep quality were assessed. Data showed significant improvements in pain severity ($p = 0.007$, $d = 0.43$), anxiety ($p = 0.011$, $d = 0.40$) and depressive symptoms ($p = 0.001$, $d = 0.50$) from pre-treatment to post-treatment.

This paper aims to further explore the potential of mobile applications in the treatment of chronic fibromyalgia pain, by implementing new gamification approaches through the development of an application called FisioQuest. The goal is to enhance patient engagement, encouraging and rewarding their continuous use of the application. To achieve these objectives, it is essential to identify and understand the specific requirements for developing such a mobile application. In the following section, the process and criteria used to determine these requirements are described in detail.

The article is structured as follows: In Section II, the requirements analysis for the FisioQuest application is detailed, outlining both functional and non-functional requirements. Section III defines specific use cases to guide the application's design. Section IV discusses the application design, including the choice of the Flutter framework and the creation of mockups. Finally, Section V addresses the integration of gamification elements to enhance user engagement and outlines plans for usability testing and a co-design process with end-users.

II. Requirements Analysis

The requirements for the development of the mobile application were determined following a literature review and analysis of case studies [17]-[19]. The research focused on identifying the functionalities and features most valued by patients and most effective in clinical practice. The main points of interest included symptom monitoring techniques, interventions based on physical and mental exercises, and the impact of gamification on treatment adherence. In addition to the scientific literature, existing mobile applications aimed at managing chronic pain were analyzed. This analysis made it possible to identify best practices and the most successful features in terms of effectiveness and engagement, without the need for direct interactions with end users.

Considering this analysis and the application's target audience, the following functional and non-functional requirements were defined.

A. Functional Requirements

- Pain report: Allow users to report, at any time, the presence of pain, indicating the location and level of pain on a 0-10 scale.
- Healthcare specific pages: The application should represent the three types of healthcare professionals who interact with fibromyalgia patients, namely: physicians, nurses and physiotherapists.
- Physician's page: Monitor and record the medication taken daily by the patient.
- Nurse's page: Record and monitor the patient's weight and blood pressure.
- Physiotherapist's page: Recommend suitable physical exercises for fibromyalgia patients and verify their accomplishment.
- Morning/evening questionnaires: Display morning and evening questionnaires on the main page; collect and store user responses for ongoing monitoring.
- Streak system: Implement a streak system to record consecutive days of app utilization and notifies users of their current streak status and daily goals.
- Streak rewards: Allow users to redeem the reward after completing a streak.
- User profile: Display average daily pain statistics in graphical format.

B. Non-Functional Requirements

- Usability: The interface should be intuitive, using basic icons and a minimalist design to reduce cognitive load for FMS patients. Navigation should be simple, allowing quick access to main sections.

- Engagement: Integrate push notifications to remind users of daily tasks and rewards. Use gamification elements to keep users engaged and motivated.
- Performance: The application should load promptly and respond effectively to user interactions.
- Security and privacy: User data must be protected, ensuring compliance with General Data Protection Regulation (GDPR).
- Reliability: The application must minimize crashes and service interruptions. In case of network failure, data must be temporarily stored on the device and synchronized once the connection is restored.
- Compatibility: The application should be compatible with major mobile operating systems (iOS and Android), screen sizes and resolutions.

III. USE CASES

In order to prototype the user interface, it is important to clearly identify the use cases for the FisioQuest application. To this end, six use cases were defined:

- Pain report - After experiencing an outbreak of pain, the patient opens the pain reporting page. The user selects the location of the pain (from a list) and rates the pain on a scale of 0 to 10. The data is stored in the database and can be viewed in the user's profile in the form of a daily pain graph. Over time, the user and their healthcare provider can track pain patterns and adjust treatments accordingly.
- Daily medication check - A user opens the Physician page to check their medication plan for the day. The page displays a list of medications with checkboxes next to each one. As the user takes their medication, he/she ticks the checkboxes, and the app records the intake. This information is then synchronized with the main screen, showing the "Physician" task as completed for the day.
- Performing an exercise - The user navigates to the physiotherapist's page, where he/she is presented with the list of daily exercises that have been prescribed. Each exercise includes a short video/image and notes on how to properly perform the exercise. The user completes the exercise and marks it as finished. The application records the completion and updates the streak counter.
- Daily questionnaires - In the morning and evening, the user is notified to fill in the daily questionnaires. The Morning Questionnaire asks about the user's sleep quality and morning pain levels, while the Evening Questionnaire asks about general daily pain and how he/she felt throughout the day. The answers are recorded and stored in the database, providing data for monitoring symptoms and identifying potential triggers or patterns.
- Health monitoring - On the Nursing page, users can record their daily weight and blood pressure. They should also mark the daily tasks they have been prescribed, such as "Bathing", "Making the bed", among other activities. This information is stored in the database. Healthcare professionals will be able to observe how weight and blood pressure vary and correlate with pain levels and medication adherence.
- Rewards system - After keeping a series of daily tasks completed for a predefined number of consecutive days, the user receives a notification about their reward. The user can navigate to the rewards section and choose to schedule a teleconsultation with a healthcare professional.

IV. APPLICATION DESIGN

Following the definition of the functional and non-functional requirements, and identifying the use cases, the process of designing the FisioQuest application began by choosing the framework to be used for its development. Considering the non-functional requirements, it was decided to adopt the Flutter framework, which guarantees, among other advantages: the ability to develop a single code base for multiple platforms, such as Android and iOS; the creation of intuitive, visually rich and pleasant user interfaces; high application performance, allowing for fast and responsive navigation/interaction.

A. Application Mockups

Figure 1. Mockups of the FisioQuest mobile application.

To be able to preview the layout and test the functionality of the application, wireframes and detailed mockups were created which served as models during the development process. The mockups of the main screen of the FisioQuest mobile application are illustrated in Figure 1.

Below is a brief description of the key screens of FisioQuest application:

a) Login page: User authentication page.

b) Main page: Provides quick access to main features.

c) Morning / Evening Questionnaire: Prompts users with questions about sleep quality / morning pain (morning) and daily pain levels and overall condition (evening).

d) Physician Page: Allows drug schedules tracking.

e) Nursing Page: Allows users to record their daily weight and blood pressure levels.

f) Physiotherapist Page: Provides videos, images and notes to assist users in performing their daily exercises.

g) Pain Reporting Page: Allows users to report their pain levels and locations.

h) User Profile Page: Displays user pain statistics.

i) Main Page: Allows users to see their streak status.

j) Reward Page: Allows users to claim a reward by scheduling a teleconsultation.

k) Notification: Notifies users of pending activities.

B. Integrated Gamification Elements

To encourage user participation and engagement, gamification elements have been integrated into the app. The streak system promotes daily use by tracking usage on consecutive days and notifying users about current streak status and daily goals. When a streak is completed, users can redeem the reward. To make the rewards truly attractive, patients can schedule teleconsultations with health professionals from the Chronic Pain Unit. Instant feedback is given on the user's progress (adherence to medication, reporting of symptoms, physical exercise), thus seeking to reinforce positive behavior. The daily questionnaires (morning and evening) act as regular checks, promoting self-reflection and continuous monitoring of symptoms.

V. Conclusion and Future Work

Previous studies have pointed to a reduction in pain intensity and an improvement in associated symptoms, such as anxiety and depression, whenever the use of mobile applications was promoted in the approach to chronic pain treatment. The reduction in symptoms with the use of mobile apps can be attributed to the combination of various functionalities, such as performing the recommended physical exercises, better psychotherapeutic support, and improving the quality of data on the patient's condition by continuously monitoring symptoms. These elements are especially important for FMS patients, who often face difficulties in maintaining a self-care routine due to pain and fatigue. It is therefore vital that patients make continued use of the app, and gamification can be a crucial factor.

This paper presents FisioQuest, a mobile app (under development) that incorporates gamification elements to increase patient engagement and facilitate the self-management of pain. The app aims to offer an accessible and convenient solution to complement traditional treatments, reducing the need for pharmacological interventions and their long-term side effects. Additionally, continuous symptom monitoring and recording can enable faster, more effective, and personalized interventions.

The application should initially be subjected to usability tests using the System Usability Scale (SUS) to assess the ease of use of the app and the overall user experience. After the usability testing, a co-design process will be initiated to further enhance the application. This phase will involve the participation of end-users, who will be invited to engage in tests and interviews. Their feedback and insights will play a crucial role in refining the application, ensuring that it meets the needs and expectations of its users effectively. This would be followed by validation through a controlled study, to verify whether the benefits observed were the result of placebo effects or the initial motivation of the participants.

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References

[1] M. Nicholas et al., “The IASP classification of chronic pain for ICD-11: chronic primary pain. Pain, ” Pain, vol. 160, no. 1, pp. 28-37, Jan. 2019, doi: 10.1097/j.pain.0000000000001390.

[2] L. Goudman et al., "Virtual Reality Applications in Chronic Pain Management: Systematic Review and Meta-analysis," JMIR Serious Games, vol. 10, no. 2, pp. e34402, May 2022, doi: 10.2196/34402.

[3] A. S. Gonçalves, F. Monteleone, M. B. Couto, M. E. Machado, and M. E. Pereira, "From automatic thoughts to painful processes: a review on the use of cognitive-behavioral therapies in the management of chronic pain," Revista DOR, vol. 29, no. 1, Nov. 2022, doi: 10.24875/DOR.22000003.

[4] D. Teater, The psychological and physical side effects of pain medication, National Safety Council, 2015. [Online]. Available from: https://www.nsc.org/getmedia/0113f259-d2c5-4a3e-abca-f05299f65ec2/adv-rx-side-effects-wp.pdf 2024.09.26

[5] M. D. Cheatle, "Prescription opioid misuse, abuse, morbidity, and mortality: balancing effective pain management and safety," Pain Med., vol. 16, suppl. 1, pp. S3-S8, Oct. 2015, doi: 10.1111/pme.12904. PMID: 26360931.

[6] S. L. K. Yuan, L. A. Couto, and A. P. Marques, "Effects of a six-week mobile app versus paper book intervention on quality of life, symptoms, and self-care in patients with fibromyalgia: a randomized parallel trial," Braz J Phys Ther., vol. 25, no. 4, pp. 428-436, Jul-Aug 2021, doi: 10.1016/j.bjpt.2020.10.003.

[7] F. Wolfe et al., "The American College of Rheumatology preliminary diagnostic criteria for fibromyalgia and measurement of symptom severity," Arthritis Care Res (Hoboken), vol. 62, no. 5, pp. 600-10, May 2010, doi: 10.1002/acr.20140. PMID: 20461783.

[8] P. Sarzi-Puttini et al., "Fibromyalgia: an update on clinical characteristics, aetiopathogenesis and treatment," Nat Rev Rheumatol, vol. 16, pp. 645–660, 2020, doi: 10.1038/s41584-020-00506-w.

[9] R. de la Vega, R. Roset, S. Galán, and J. Miró, "Fibroline: A mobile app for improving the quality of life of young people with fibromyalgia," Journal of Health Psychology, vol. 23, no. 1, pp. 67-78, 2018, doi: 10.1177/1359105316650509.

[10] S. L. K. Yuan and A. P. Marques, "Development of ProFibro - a mobile application to promote self-care in patients with fibromyalgia," Physiotherapy, vol. 104, no. 3, pp. 311–317, 2018, doi: 10.1016/j.physio.2018.04.005.

[11] J. An, W. Fan, A. Mittal, Y. Zhang, and A. T. Chen, "Mobile App Use among Persons with Fibromyalgia: A Cross-sectional Survey," J Pain, Mar. 24, 2024, doi: 10.1016/j.jpain.2024.03.011.

[12] J. Miró, M. Lleixà-Daga, R. de la Vega, P. Llorens-Vernet, and M. P. Jensen, "A Mobile Application to Help Self-Manage Pain Severity, Anxiety, and Depressive Symptoms in Patients with Fibromyalgia Syndrome: A Pilot Study," Int. J.

Environ. Res. Public Health, vol. 19, no. 19, p. 12026, 2022, doi: 10.3390/ijerph191912026.

[13] N. X. Thanh et al., "Economic burden of chronic pain in Alberta, Canada," PLoS ONE, vol. 17, no. 8, p. e0272638, 2022, doi: 10.1371/journal.pone.0272638.

[14] L. Barham, "Economic Burden of Chronic Pain Across Europe," Journal of Pain & Palliative Care Pharmacotherapy, vol. 26, no. 1, pp. 70–72, 2012, doi: 10.3109/15360288.2011.650364.

[15] T. Takura et al., "The societal burden of chronic pain in Japan: an internet survey," J Orthop Sci, vol. 20, pp. 750–760, 2015, doi: 10.1007/s00776-015-0730-8.

[16] L. F. Azevedo et al., "The economic impact of chronic pain: a nationwide population-based cost-of-illness study in Portugal," Eur J Health Econ, vol. 17, pp. 87–98, 2016, doi: 10.1007/s10198-014-0659-4.

[17] M. Cascella et al., "Envisioning gamification in anesthesia, pain management, and critical care: basic principles, integration of artificial intelligence, and simulation strategies," J Anesth Analg Crit Care, vol. 3, p. 33, 2023, doi: 10.1186/s44158-023-00118-2.

[18] A. S. Miller, J. A. Cafazzo, and E. Seto, "A game plan: Gamification design principles in mHealth applications for chronic disease management," Health Informatics Journal, vol. 22, no. 2, pp. 184-193, 2016, doi: 10.1177/1460458214537511.

[19] L. Sardi, A. Idri, and J. L. Fernández-Alemán, "A systematic review of gamification in e-Health," Journal of Biomedical Informatics, vol. 71, pp. 31-48, Jul. 2017, doi: 10.1016/j.jbi.2017.05.011.