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Mobile application for the prevention and self-care of varicose veins

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ABSTRACT

Details the process of creating a prototype of a mobile application designed to promote prevention and self-care of varicose veins in patients at high vascular risk. The objective is to investigate the experience of patients at high vascular risk when using a mobile application created for the prevention and self-care of varicose veins. The methodology used is design thinking, a user-centered approach that seeks to solve complex challenges through creativity, design and problem solving. The results obtained from the expert judgment, based on ATLAS.ti 23, provide valuable insight into the feasibility and potential of the technological tools as the interface has the highest variability among the criteria evaluated, followed by interaction and quality, while usability presents the lowest variability. This suggests that usability evaluations tend to be more consistent compared to the other criteria. In conclusion, the present work analyzes how mobile applications can play a crucial role in promoting prevention and self-care of varicose veins in patients at high vascular risk. The good reception of the prototype confirms the importance of technology in the field of vascular health and highlights the value of this approach to improve quality of life and health management in this demographic group.

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1. INTRODUCTION

Globally, varicose veins represent a major vascular health challenge, affecting people of all ages and genders in different regions of the world [1]. It is estimated that millions of individuals suffer from this condition, and due to the aging of the population and changes in lifestyles, its prevalence continues to increase. In addition to the negative impact on the quality of life of sufferers, varicose veins generate a considerable economic burden due to the costs associated with treatment and loss of work productivity. This worldwide phenomenon highlights the importance of addressing varicose veins as a global public health priority [2]. In addition, several countries have identified varicose veins as a relevant public health problem and have implemented policies and programs to address this condition [3]. International health organizations have stressed the importance of preventing and treating vascular diseases, including varicose veins, as part of global efforts to promote population health. These international health programs may include educational campaigns, preventive actions, and improving access to specialized medical services for the treatment of vascular disorders [4].

Varicose veins are a common venous condition that presents a significant vascular health challenge, especially in patients at high vascular risk. With an aging population and increasing sedentary lifestyles, the

prevalence of varicose veins and their associated complications continues to rise [5]. Although there are various medical and surgical options to treat varicose veins that have already developed, prevention and self-care play a key role in the effective management of this condition.

At the national level, health systems in different countries strive to address the problem of varicose veins by introducing specific health policies and allocating resources to prevent, diagnose and treat this condition [6]. Health programs at the national level can include training medical professionals in the management of varicose veins, offering comprehensive care services in health facilities and hospitals, as well as promoting healthy lifestyle habits as a preventive measure against varicose veins. In the digital era, there has been an increase in the creation of mobile applications focused on health, which represents a special opportunity to improve the prevention and self-management of varicose veins [7]. These applications can provide educational information, exercise and healthy habit reminders, as well as follow-up tools to monitor the evolution of the disease and the effectiveness of interventions. Effective management of varicose veins in patients at high vascular risk involves one fundamental aspect: self-care. Varicose veins, a common condition characterized by dilation and twisting of superficial veins, can be particularly challenging for those at increased vascular risk due to factors such as advanced age, family history and concurrent medical conditions [8]. Self-care becomes crucially important in this context, as it can help alleviate symptoms associated with varicose veins, prevent complications, and improve the patient's quality of life. However, understanding how patients at high vascular risk experience and manage varicose vein self-care is essential to developing effective, patient-centered interventions [9].

On the other hand, local actions and primary health care services are essential in the prevention and treatment of varicose veins. Community health centers provide diagnosis, treatment and follow-up services to affected patients, as well as education on self-care and prevention of complications [10]. In addition, non-governmental organizations and local support groups can provide resources and emotional support to people living with varicose veins in the community, thus helping to improve the quality of life of those affected at the local level. The implementation of a mobile application for the prevention and self-care of varicose veins opens up new opportunities in the treatment of this condition. By providing information and resources related to varicose veins in an accessible and convenient way, it aims to empower patients to take an active role in their vascular care [11]. In addition, digital tracking could improve monitoring of disease progression and facilitate communication between patients and healthcare professionals [12]. However, it is essential to recognize that the use of mobile applications in vascular health presents particular challenges, such as ensuring the privacy and security of patient data, as well as addressing accessibility and digital inclusion. These aspects must be considered holistically to maximize the positive impact of technology in the prevention and management of varicose veins.

The selected methodology will be design thinking, a user-oriented approach that focuses on deeply understanding people's needs and desires to devise innovative and effective solutions [13]. It is based on an iterative process of continuous learning and refinement during the development of user-centric solutions. This approach is particularly appropriate for projects that seek to address complex challenges and create solutions that genuinely meet user needs [14].

The importance of the research work lies in its contribution to the field of vascular health by exploring the potential of mobile technology as an effective tool for the prevention and self-care of varicose veins. By investigating in a rigorous, patient-centered manner, it seeks not only to understand the efficacy of these digital interventions, but also their acceptability and practical utility for those living with this condition. This innovative approach helps advance the search for more accessible, user-centered solutions, with the ultimate goal of improving patients' quality of life and preventing complications associated with varicose veins. The aim of this study was to investigate the experience of patients at high vascular risk when using a mobile application created for the prevention and self-care of varicose veins. The aim is to understand the effectiveness and acceptance of this digital tool in the management of varicose veins, as well as its impact on the quality of life of affected patients.

2. LITERATURE REVIEW

In principle, the research has allowed us to detail the prevention and self-care of varicose veins in patients at high vascular risk, identifying effective strategies and key factors. This approach seeks to improve interventions to reduce complications and improve the quality of life in this group of patients. Yan *et al.* [15], examine that a considerable proportion of patients with compensated advanced chronic liver disease (CLD) have no varicose veins or only low-risk varices. Therefore, they aimed to develop and validate a simple risk scoring system to identify high-risk varicose veins and avoid unnecessary esophagogastroduodenoscopies in patients with hepatitis B. They used multivariate logistic regression statistical analysis to identify independent risk factors for the presence of high-risk varicose veins in order to establish this scoring system for high-risk varices screening. These criteria were tested in an initial group of 221 patients and validated in a

second group of 113 patients. As a result, they found that, in the first group, 29.5% had high-risk varicose veins. When the albumin-platelet-portal vein diameter albumin-platelet score (APP score) was <0.24, the negative predictive value was >95%. A total of 125 of 221 (56.6%) patients obtained an APP score <0.24, with an esophageal variceal failure rate of 4.8%. In the second group, 59 of 113 (51.3%) patients achieved an APP score <0.24, with an esophageal variceal failure rate of 1.7%. The investigators conclude that the APP score is a promising model for safely detecting high-risk varicose veins and avoiding unnecessary esophagogastroduodenoscopies in patients with compensated advanced chronic hepatitis B virus-related chronic liver disease.

Although associations between varicose veins and physical function have been reported in some studies, this relationship has not been systematically evaluated in the general population. Mok *et al.* [16], conducted a study in 5,580 participants aged 71 to 90 years from the Atherosclerosis Risk in Communities (ARIC) study. They identified varicose veins in 230 participants (4.1%) through medical data. They found a cross-sectional association between varicose veins and reduced physical function in community-dwelling older adults. Longitudinally, low physical function was a risk factor for the development of varicose veins, but not vice versa. These results suggest a causal role of low physical function in the occurrence of varicose veins. Likewise, Sedgwick *et al.* [17], expose the significant impact of peripheral vascular diseases on functional quality of life. Highlighting the complex and costly economic implications, such as the chronicity of lower extremity ulcerations and the possibility of ischemic amputation. In response to this need, they developed a new portable boot-shaped intermittent negative pressure medical device known as FlowOx™. To better understand the perception of this device, qualitative interviews were conducted with patients and physicians. The opinions gathered revealed a positive assessment from both patients and physicians, highlighting the ease of use of the device. In addition, the authors found a particularly significant benefit among patients with varicose vein disease and peripheral arterial disease, especially in cases of ischemic ulceration, compared to those with chronic venous disease.

On the other hand, Anwar *et al.* [18] set out to evaluate the effectiveness of an educational program aimed at nurses to reduce the risk of varicose veins, one of the most common occupational diseases in this occupational group worldwide. To do so, they conducted a quasi-experimental study in the main health center, covering areas such as the operating room, general medicine and surgery. They used a structured questionnaire to assess knowledge, as well as a comprehensive varicose vein rating scale and a self-reported questionnaire on nursing practices for varicose vein prevention. The results revealed a significant positive correlation ($r = 0.332$) between the level of knowledge and the implementation of basic preventive health measures for varicose veins. In conclusion, the implementation of the educational program succeeded in improving nurses' knowledge and practices, leading to a decrease in the risk of developing varicose veins.

The importance of investigating non-surgical treatment alternatives in the management of varicose veins is emphasized. Albarqy and AlQarni [19], emphasize that a comprehensive approach to treating varicose veins involves understanding their causes and risk factors, exploring treatment options that do not involve surgery, and considering surgical interventions when necessary. Thus, understanding the causes and risk factors is essential to effectively prevent and treat varicose veins. It is emphasized that a combination of factors such as venous valve dysfunction, age, gender, family history, obesity, pregnancy, and prolonged periods of inactivity contribute to these causes and risk factors for varicose veins. In conclusion, surgical options such as high ligation and stripping, endovenous laser ablation and ambulatory phlebectomy are effective in treating advanced varicose veins, providing symptomatic relief and improving patients' overall quality of life. With lifestyle changes, conservative measures and medical treatments, patients can effectively relieve symptoms, improve their quality of life and reduce the risk of complications.

According Wu *et al.* [20], synthesize that varicose vein, although common and considered benign, can have serious health implications. This study investigated the relationship between the severity of varicose veins and cardiovascular and mortality risks. Patients with varicose veins were found to have an increased risk of mortality compared to those without the condition, especially among those over 65 years of age and men. These findings suggest that varicose veins deserve attention in terms of prognosis and treatment. According to Thanka *et al.* [9], Varicose veins are a chronic condition caused by a malfunction in the blood circulation in the veins of the legs, which causes problems in the flow of blood from the legs to the heart. This is due to the accumulation of blood in the veins, known as stasis, which causes damage to the venous valves. Factors such as prolonged standing or sitting, aging and lack of mobility are major causes of this chronic disease, which can be costly to treat. Early detection is crucial in alleviating the associated pain and discomfort. The use of deep learning techniques, such as convolutional neural networks, plays a crucial role in early prediction and identification of the different stages of varicose veins, which aids physicians in diagnosis and treatment. A proposed model based on a multidimensional deep convolutional neural network has demonstrated an exceptional accuracy of 99.9% in classifying the different stages of chronic venous insufficiency, facilitating appropriate treatment for patients.

On the other hand, Evans *et al.* [21], investigated the prevalence of varicose veins and chronic venous insufficiency (CVI) in the general population, randomly examining men and women aged 18 to 64 years from 12 general practices. They found that truncal varicose veins were more common in men (40%) than in women (32%), while CVI affected 9% of men and 7% of women. The prevalence of all categories of varicose veins and CVI increased with age. These findings contradict previous studies, suggesting possible changes in the epidemiology of venous disease, with no evidence of study bias to explain the gender difference. An association between varicose veins and an increased risk of venous thromboembolism (VTE) has been observed in several observational studies, but it is unclear whether this association is causal. To address this question, Li *et al.* [22], used Mendelian randomization (MR) methods to investigate this relationship. Using genetic data from UK Biobank, they identified single nucleotide polymorphisms associated with varicose veins. They then analyzed VTE data sets from the FinnGen study. After adjusting for confounders such as body mass index and height, they found that genetically predicted varicose veins may have a causal effect on deep vein thrombosis (DVT) and may be one of the mediators of obesity and increased height predisposing to DVT. Finally, Alsaigh and Fukaya [23], emphasize that chronic varicose vein disease (CVD) is a growing global health problem that carries a significant burden of disease. It is characterized by venous insufficiency and chronic venous hypertension, manifesting with symptoms such as pain, edema, skin pigmentation, dilated veins in the extremities and, in severe cases, skin ulcers. Pathophysiology involves a complex interplay of inflammation and tissue remodeling, and current treatment is based on a variety of technical advances. This article provides a detailed review of the anatomy, pathophysiology, genetics, clinical classification, and treatment options available for CLD.

In conclusion, an exhaustive review of the literature on the subject has been carried out by various authors. However, some of them have not been able to achieve the proposed objective. Therefore, this analysis provides an opportunity to implement more in-depth and effective measures to adequately address the identified problem.

3. METHOD

Design thinking is a user-centered method used to solve complex problems and generate innovative solutions. It is based on a deep understanding of users' needs, desires and contexts, which allows the design of products, services or processes that truly satisfy them. This approach is valuable because it prioritizes user-driven solutions, fosters creativity, facilitates collaboration among multidisciplinary teams, enables adaptability and flexibility, promotes rapid prototyping, and takes a holistic approach to complex challenges [24]. The design thinking process generally follows five main phases in an iterative cycle. As shown in Figure 1.

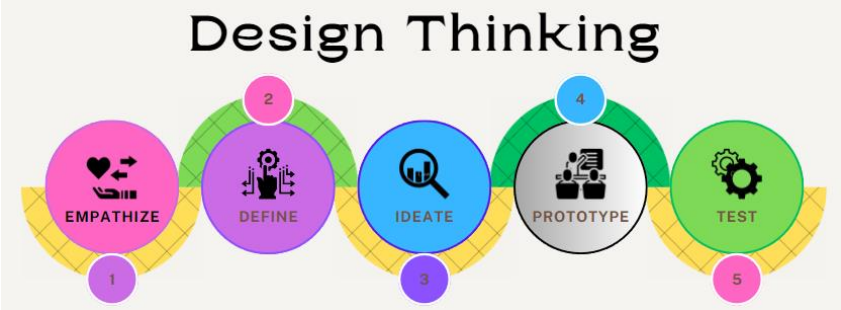


Figure 1. Phases of the design thinking methodology

3.1. Empathize

In this initial phase, it is essential to immerse oneself in a deep understanding of the needs, desires and contexts of the users involved in the problem. This understanding is achieved through direct observation, interviews and genuine empathy toward the users, to obtain a clear vision of their experiences and challenges [25]. It is essential to practice active listening, demonstrating empathy and genuine understanding, to capture not only what they express verbally, but also their emotions and experiences related to the problem at hand. This approach helps to develop an empathetic connection with users and lays the foundation for designing solutions that are truly user-centric. Table 1 presents the questions related to the prevention of varicose veins in patients at high vascular risk. Each question addresses specific aspects related to risk factors, recommended preventive measures, the role of physical activity, and the use of technologies such as mobile

applications in the prevention of this disease. These questions will serve as a guide for the collection of relevant information during the study on the effectiveness of varicose vein prevention strategies in this patient population.

Table 1. Questions about varicose vein prevention in patients at high vascular risk.

N°	Questions
1	What are the main risk factors contributing to the development of varicose veins in patients at high vascular risk?
2	What preventive measures are recommended to reduce the risk of developing varicose veins in people with a family history of the disease?
3	What is the role of physical activity in the prevention of varicose veins in patients at high vascular risk?
4	Have you currently used any mobile application or other technologies for the prevention of varicose veins with high vascular risk?

3.2. Define

During the defined phase of the design thinking process, the information gathered in the Empathy stage is condensed to have a clear understanding of the problem to be addressed. In addition, the project objectives are precisely established, measurable success criteria are defined, and the scope of the design is delimited to ensure that the team is fully focused on solving the problem effectively and efficiently [26]. This phase ensures a clear direction and focuses on effective problem solving. Table 2 presents four key dimensions along with questions related to the development of a mobile application for varicose vein management. These dimensions include emotional support, accessibility, monitoring, and motivation. Each question addresses specific aspects of how a mobile application can improve the user experience by providing emotional support, ensuring accessibility for different user groups, providing monitoring tools to record symptoms and progress, and motivating users to adopt healthy habits through gamification.

Table 2. Dimensions and questions on mobile application for varicose vein management.

Dimensions	Questions
Support	How could a mobile app provide emotional support to users facing challenges in managing their varicose veins?
Accessibility	What accessibility features should a mobile app have to ensure that it is easy to use for people of all ages and technology skill levels?
Monitoring	What tracking and monitoring tools could be integrated into a mobile app so that users can easily record and monitor their symptoms and progress in managing varicose veins?
Motivation	How could a mobile app use gamification to motivate users to maintain healthy habits and follow varicose vein prevention recommendations?

Table 3 compares the current situation with the proposed situation regarding a mobile application for varicose vein management, focusing on four dimensions: support, accessibility, monitoring and motivation. In the current situation, shortcomings are identified in each dimension, such as lack of mobile application for emotional support, accessibility limitations, lack of monitoring tools and lack of motivation to maintain healthy habits. In contrast, the proposed scenario describes planned improvements for each dimension, such as the implementation of a mobile application with live chat features, accessibility features, tracking and monitoring tools, and gamification strategies to motivate users.

Table 3. Current and proposed situation

Dimensions	Current situation	Proposed situation
Support	No mobile app available to provide emotional and practical support to high vascular risk patients	A mobile application will be implemented with live chat features, support groups moderated by health professionals, and links to online communities to connect users.
Accessibility	The lack of accessibility options in mobile applications makes them difficult to use for people with visual or motor disabilities.	The mobile application will be designed with accessibility features such as large text, voice options and simplified navigation to ensure inclusive use.
Monitoring	Patients lack the tools to adequately track their symptoms and progress in the management of their varicose veins.	The mobile application will offer easy-to-use tracking and monitoring tools, allowing users to record their symptoms and receive automatic reminders to perform self-tests.
Motivation	The lack of incentives and positive feedback makes it difficult to motivate patients to maintain healthy habits and follow prevention recommendations.	The mobile app will use gamification and incentive strategies to encourage user engagement by offering reward programs and positive feedback to recognize their efforts

3.3. Ideate

During the Ideate phase of the design thinking process, creativity and collaboration among a multidisciplinary team is encouraged to generate diverse ideas and solutions to solve the identified problem [27]. The exploration of multiple approaches and perspectives is promoted through techniques such as lateral thinking, brainstorming and rapid prototyping to stimulate innovation. This stage is characterized as a space where divergence is appreciated and originality is sought in the generation of ideas. The main objective is to consider all possibilities before selecting the most promising ideas to continue with the design process. Table 4 shows the activities agreed upon for the design of a mobile application focused on the prevention of varicose veins in patients at high vascular risk. Four dimensions are highlighted: support, accessibility, monitoring, and motivation. Each dimension includes specific questions that guide the design, such as registration, chat functions, intuitive interface, monitoring tools and gamification elements. These activities seek to ensure an effective and motivating application for users.

Table 4. Consensus activities for the design of the mobile application

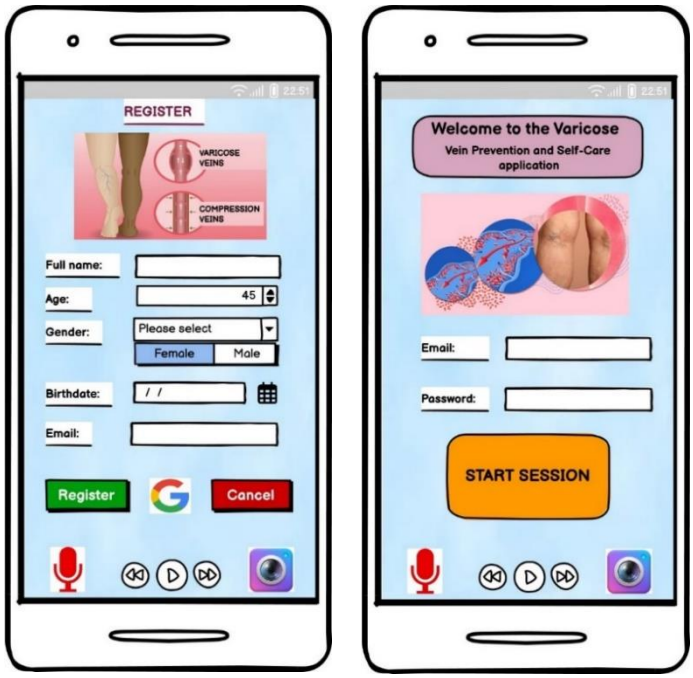
Dimensions	Consensual activities
Support	Design registration and login to enter the application for varicose vein prevention in patients at high vascular risk.
	Realize a design that will include live chat features or support groups moderated by health professionals, where users can share their experiences, ask questions, and receive emotional guidance.
Accessibility	The design of the mobile application should have an intuitive and user-friendly interface, with customization options to suit individual user preferences.
Monitoring	The mobile application shall include tools for users to record their daily symptoms, physical activity levels, and compliance with recommended treatment.
	Set up automatic reminders for users to perform regular self-examinations of their legs and provide feedback on the consistency of their monitoring.
Motivation	The mobile app design will use gamification elements, such as virtual rewards and personalized challenges, to motivate users to follow healthy habits and meet their self-care goals.

3.4. Prototype

In the prototyping stage of the design thinking process, the most promising ideas originating from the ideation phase are selected. From these selected ideas, simple, rapid prototypes are created that serve as a visual representation of the possible proposed solutions [28]. These prototypes are developed in an agile and adaptable way, to evaluate the ideas at an early stage and obtain valuable feedback quickly. For the design we used the Balsamiq tool that allows to create quick and simple prototypes of web and mobile applications [29]. Figure 2 shows the design of the mobile application, which includes both the registration screen and the welcome screen. Figure 2(a) shows the registration process in the mobile application designed to prevent varicose veins in patients at high vascular risk. Users must complete a form where they enter their personal information, such as name, age, gender, and contact details. In addition, they are asked to create a username and password to access the application in future sessions. Figure 2(b) shows the welcome screen of the mobile application. After completing registration, users are greeted with a welcome message that provides them with information about the application and its main features.

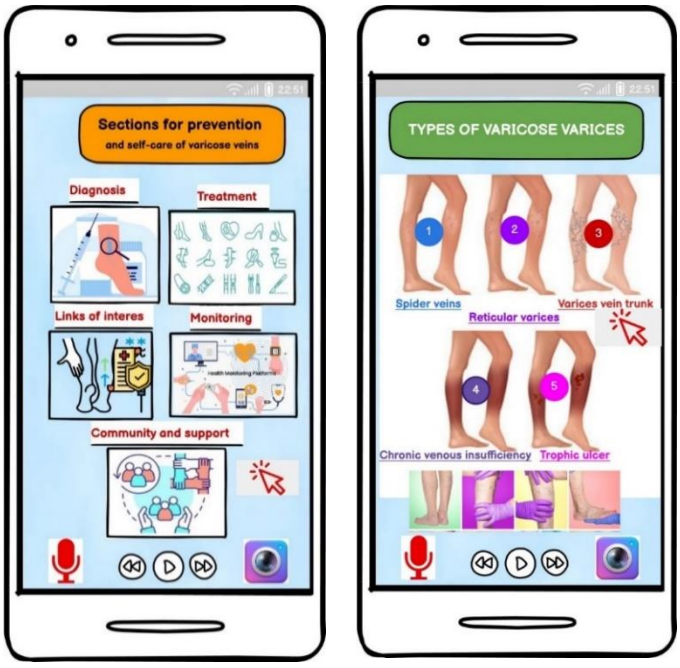
Figure 3 shows the design of the mobile application to prevent varicose veins in patients at high vascular risk, both the screen of the prevention sections and the types of varicose veins. Figure 3(a) shows the different sections dedicated to the prevention of varicose veins in patients at high vascular risk. These sections may include information on healthy habits, recommended exercises, lifestyle tips, preventive measures, and available treatments. Users can navigate through these sections to access educational content and useful resources to prevent the onset or worsening of varicose veins. Figure 3(b) provides detailed information on the different types of varicose veins that may affect patients at high vascular risk. This may include descriptions of symptoms, risk factors, diagnosis, and treatment options specific to each type of varicose vein. Users can consult this information to better understand their condition and make informed decisions about their care and prevention.

Figure 4 shows the classes of venous leg disease and varicose veins. Figure 4(a) presents the different classes of venous leg disease that may affect patients at high vascular risk. This may include information on varicose veins, chronic venous insufficiency, deep vein thrombosis, and other disorders related to the venous system of the legs. Each class of venous disease may have unique characteristics in terms of symptoms, risk factors, diagnosis, and treatment options, and this section provides users with a more complete understanding of their condition and potential complications. Figure 4(b) in this part of the mobile app provides specific information on varicose veins, which is one of the most common conditions of venous disease in the legs. Users can learn about the characteristic symptoms of varicose veins, such as enlarged and twisted veins, as well as the associated risk factors and treatment options available to manage this condition.



(a) (b)

Figure 2. Mobile application: (a) registration and (b) welcome



(a) (b)

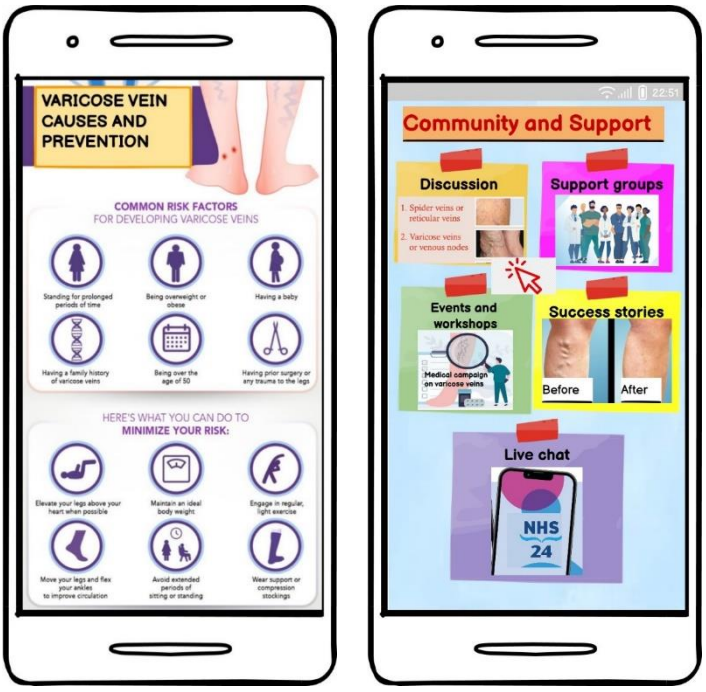
Figure 3. Mobile application: (a) prevention sections and (b) type of varices

Figure 5 presents a clear division of two main sections of the mobile application designed to prevent varicose veins in patients at high vascular risk. Figure 5(a) shows the causes and prevention of varicose veins: This section provides comprehensive information on the causes that can lead to the development of varicose veins in patients at high vascular risk. In addition, it provides specific prevention strategies, including lifestyle changes, recommended exercises, and preventive measures to reduce the risk of varicose veins. Also, Figure 5(b) shows the community and support: here a space for social interaction is created

where users can connect, share experiences, ask questions, and receive emotional and practical support. This virtual community can include support groups moderated by health professionals and links to additional resources to provide a strong support network for users in their varicose vein prevention and treatment process.

(a) (b)

Figure 4. Mobile application: (a) types of venous disease and (b) varicose veins



(a) (b)

Figure 5. Mobile application: (a) varicose veins causes and prevention and (b) community and support

4. RESULTS

4.1. About the interview

Participants in the study demonstrate a high level of awareness and understanding regarding risk factors associated with varicose vein development. There is a clear identification of elements such as genetic predisposition, sedentary lifestyle, advanced age, medical history, and overweight as determinants in increasing vascular risk. Furthermore, participants show an active commitment to adopting effective preventive measures, such as maintaining a healthy weight, avoiding prolonged periods of inactivity, using compression stockings, and engaging in regular physical exercise. This behavior suggests a deep understanding of the importance of physical activity in improving blood circulation and mitigating symptoms associated with varicose veins. Additionally, the integration of modern technologies, such as mobile applications and tracking devices, reflects a proactive attitude towards adopting innovative tools for vascular health care and overall well-being as shown in Figure 6.

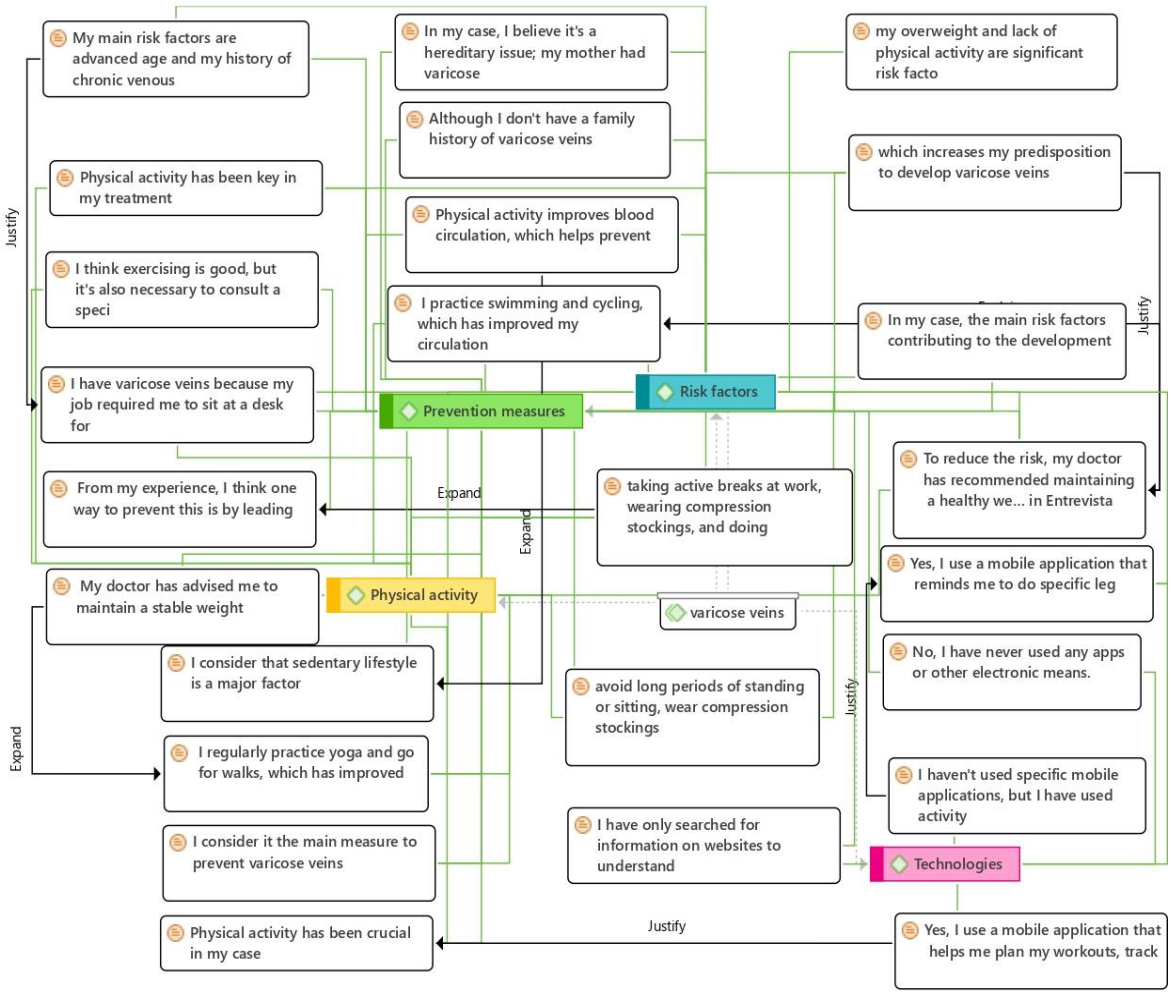


Figure 6. Dimensions with ATLAS.ti 23

4.2. Testing by experts

The violin plot shows that the "Interface" criterion has the highest variability, with a standard deviation of approximately 5 units around the mean of 95. In comparison, the "Usability" criterion has lower dispersion, with a standard deviation of around 3.26 units around the mean of 88.75. The "Interaction" and "Quality" criteria have similar standard deviations of approximately 5 units around their respective means of 85. This indicates that, overall, the data for "Usability" is more concentrated around its mean compared to the other criteria as shown in Table 5 and Figure 7.

Table 5. Expert validation

Criteria	E1	E2	E3	E4	E5	E6	E7	E8	Media
Interaction	90	80	80	90	90	90	80	80	85
Usability	90	90	90	90	80	90	90	90	88.75
Interface	100	90	100	100	90	90	90	100	95
Quality	80	90	90	80	80	80	90	90	85

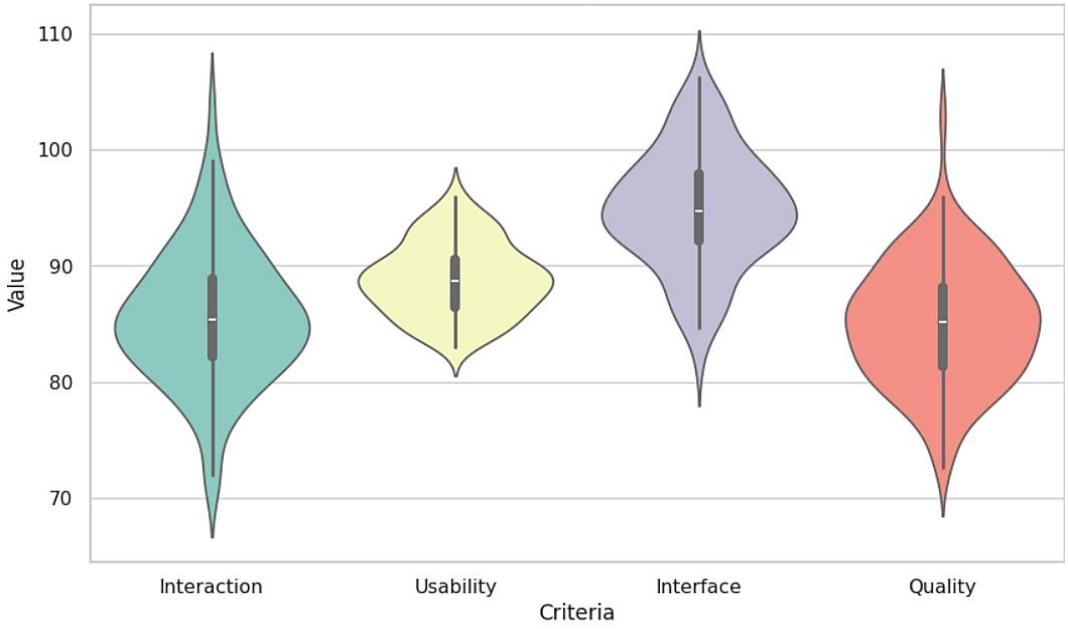


Figure 7. Criteria using the violin graph

5. DISCUSSION

Both studies aim to address problems related to varicose veins, although they have different approaches and methodologies. Yan *et al.* [15] in their risk factor identification study used multivariate logistic regression statistical analysis in a population of 221 patients initially and 113 patients in a second group to establish a scoring system. They found that 29.5% of patients in the first group had high-risk varicose veins and developed an APP score with a negative predictive value >95% for a subset of patients. The study focuses on developing an innovative solution to address patient needs in the management of varicose veins and venous ulcers using mobile technology. This approach reflects an effort to leverage digital tools to improve medical care and self-care.

Anwar *et al.* [18] set out to evaluate the effectiveness of an educational program aimed at nurses to reduce the risk of varicose veins, one of the most common occupational diseases in this occupational group worldwide. To this end, they conducted a quasi-experimental study in the main health center, covering areas such as operating room, general medicine and surgery. They used a structured questionnaire to assess knowledge, as well as a comprehensive varicose vein classification scale and a self-reported questionnaire on nursing practices for varicose vein prevention. Thus, the present work was conducted through interviews on varicose vein prevention in patients at high vascular risk. The results of the measurements were represented in an ATLAS.ti 23 graph.

In the present research work by developing a mobile application specifically designed for the prevention and self-care of varicose veins and venous ulcers, the study has the potential to significantly impact clinical practice. Providing patients with accessible and effective tools to manage their condition can improve their quality of life and reduce the burden on healthcare systems. The study is likely to have focused on key aspects of usability and acceptability of the mobile app, ensuring that it is easy to use and that patients are willing to integrate it into their daily routine. This is crucial to ensure the effectiveness and long-term adoption of the app. In contrast, Albarqy and AlQarni [19], do not have a mobile app design for treating varicose veins involving causes and risk factors.

6. CONCLUSION

In conclusion, the present study has investigated and developed mobile application prototypes to promote prevention and self-care of varicose veins in patients at high vascular risk. To evaluate the effectiveness and value of the proposed applications, interviews and surveys were conducted to collect the opinions of experts in the field to assess the effectiveness and usefulness of the proposed applications. The results obtained from expert judgment provide valuable insight into the feasibility and potential of these technological tools. Analysis of the violin plot results shows that interface has the highest variability among the criteria evaluated, followed by interaction and quality, while usability has the lowest variability. This suggests that usability evaluations tend to be more consistent compared to the other criteria. In terms of methodology, the design thinking approach was used, which is based on creativity, design and problem solving focused on user needs. This approach allowed an in-depth exploration of the needs and desires of patients at high vascular risk, as well as the identification of innovative solutions tailored to their specific needs. A limitation of the research work is that it was not possible to directly contact healthcare institutions to conduct interviews and perform a qualitative analysis. In future work, it is recommended to implement the prototypes of the mobile applications for the prevention and self-care of varicose veins in patients at high vascular risk, complementing them with emerging technologies such as augmented reality to further improve the user experience and health outcomes.

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