



Usability of the MoveSUS App for Physical Education Professionals in EBSEH University Hospitals

Usabilidade do Aplicativo MoveSUS para Profissionais de Educação Física em Hospitais Universitários EBSEH

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ABSTRACT

Objective: The MoveSUS application was developed to create, implement, and evaluate a tool designed to assist Physical Education professionals in managing and monitoring patients undergoing physical rehabilitation in Federal University Hospitals managed by Brazilian Company of Hospital Services (*Empresa Brasileira de Serviços Hospitalares* – EBSEH), addressing the specific demands of the Health sector. **Methods:** The research involved 14 Physical Education professionals working in these departments. Data were collected using the Portuguese version of the Mobile App Usability Questionnaire, which assesses three categories: ease of use, interface and satisfaction, and utility. Participants rated each of these categories on a scale from 1 to 7. **Results:** Our data indicated that the application received high scores in all evaluated categories. Ease of use had an average score of 5.89 ± 0.34 , showing that professionals found the application intuitive and easy to navigate. Interface and satisfaction scored an average of 6.07 ± 0.29 , revealing high satisfaction with the design and functionality. The utility category received the highest score, with an average of 6.35 ± 0.16 , highlighting that MoveSUS is highly useful in supporting the professionals' daily activities. **Conclusion:** the MoveSUS application has significant potential for clinical use in rehabilitation sectors, being both effective and easy to use. It is recommended to expand the use of the application throughout the EBSEH network, ensuring its effectiveness on a larger scale.

Keywords: Usability; Health application; Rehabilitation; Physical Education professionals; Federal university hospitals.

RESUMO

Objetivo: O projeto do aplicativo MoveSUS foi desenvolvido para criar, implementar e avaliar uma ferramenta projetada para auxiliar profissionais de Educação Física no gerenciamento e monitoramento de pacientes em reabilitação física nos Hospitais Universitários Federais (HUFs) gerenciados pela Empresa Brasileira de Serviços Hospitalares (EBSEH), atendendo às demandas específicas do setor de Saúde. **Métodos:** A pesquisa envolveu 14 profissionais de Educação Física que atuam nesses departamentos. Os dados foram coletados utilizando a versão em português do Questionário de Usabilidade de Aplicativos Móveis, que avalia três categorias: facilidade de uso, interface e satisfação, e utilidade. Os participantes atribuíram notas em uma escala de 1 a 7 para cada uma dessas categorias. **Resultados:** Nossos dados indicaram que o aplicativo recebeu altas pontuações em todas as categorias avaliadas. A facilidade de uso obteve uma pontuação média de 5.89 ± 0.34 , mostrando que os profissionais consideraram o aplicativo intuitivo e fácil de navegar. A interface e satisfação alcançaram uma média de 6.07 ± 0.29 , revelando grande satisfação com o design e a funcionalidade. A categoria utilidade obteve a maior pontuação, com uma média de 6.35 ± 0.16 , destacando que o MoveSUS é altamente útil no suporte às atividades diárias dos profissionais. **Conclusão:** o aplicativo MoveSUS tem um potencial significativo para uso clínico nos setores de reabilitação, sendo eficaz e fácil de usar. Recomenda-se a ampliação do uso do aplicativo em toda a rede EBSEH, garantindo sua eficácia em maior escala.

Palavras-chave: Usabilidade; Aplicativo de saúde; Reabilitação; Profissionais de Educação Física; Hospitais universitários federais.

Introduction

The popularization of the internet and increased economic investments in resources and technological innovations have been fundamental in meeting the

growing demand for technology in various sectors, including Public Health. The rise in demand for efficiency and quality in health services requires constant attention to ensure quality care¹. Information technology

(IT) and technological innovations play a crucial role in this context, providing tools that improve management and care processes in hospitals².

IT is now a vital component for modern hospital operations, enhancing both public and private health-care services. The adoption of mobile health (mHealth) applications plays a crucial role in improving health-care quality, personalization, and efficiency³. mHealth has shown great potential in managing chronic conditions, supporting remote monitoring, and boosting patient engagement and education⁴, particularly in the post-pandemic era, where its importance in facilitating real-time data access and patient-provider communication has surged. The use of smartphones and wearable devices enables comprehensive health management, making digital transformation essential for elevating patient care⁵.

Scientific literature underscores the importance of physical activity in the rehabilitation of hospitalized patients. mHealth and supervised exercises are increasingly highlighted for enhancing functionality and quality of life. mHealth interventions can significantly alleviate chronic lower back pain, although the educational components' additional effects were modest⁶. For elderly patients, wearable sensors have proven more sensitive than traditional metrics in tracking functional status changes, promoting active and healthy aging⁷.

Studies such as Slingerland et al.⁸, show a decline in physical activity after retirement, emphasizing the need for interventions to maintain functionality in the elderly. Yeo et al.⁹, further revealed that mHealth-based exercises improved insulin sensitivity in hepatocellular carcinoma patients and benefited cardiorespiratory fitness and quality of life. Systematic reviews, including Sampath Kumar et al.¹⁰, confirm the efficacy of physical activity in reducing insulin resistance in type 2 diabetes, drawing parallels for populations with other comorbidities, such as cancer.

The objective of this article is to evaluate the usability of the MoveSUS application specifically for Physical Education professionals working in the rehabilitation sectors of university hospitals managed by Brazilian Company of Hospital Services (*Empresa Brasileira de Serviços Hospitalares* – EBSEH). The study aims to understand how the application meets the needs of these professionals in their daily practices and its potential impact on the quality and efficiency of care provided to patients in rehabilitation.

Methods

This study is quantitative and descriptive, the selection of participants followed a convenience sampling approach. The study population consisted of Physical Education professionals from the rehabilitation sectors of the 41 University Hospitals in the EBSEH. All professionals were invited to participate in the project through an “Invitation and Presentation Letter” (Supplementary material 01). All participants signed an Informed Consent Form and a Confidentiality Agreement before participating in the project stages.

Usability data for the MoveSUS web application were collected using mobile health application usability questionnaires. Responses were obtained from professionals at 8 University Hospitals in the Northeast region, 2 in the Midwest region, 2 in the Southeast region, and 2 in the South region of Brazil. The intention was to invite all professionals from the EBSEH network's rehabilitation sectors to participate, ensuring a comprehensive assessment of usability across a diverse range of settings. Initially, 27 professionals responded to the preliminary questionnaire aimed at identifying technological needs prior to the development of the MoveSUS application. Of these, 14 professionals continued to participate in the subsequent stages of the project, including the usability evaluation.

The inclusion criteria for the study were: a) being a Physical Education professional in the rehabilitation area of University Hospitals in the EBSEH; b) responding to the research questionnaires and being available to evaluate the application's usability when requested; c) having signed the informed consent form; and d) having signed the confidentiality agreement. The exclusion criterion was: a) not being a Physical Education professional from University Hospitals in the EBSEH.

Application development stages and usability evaluation

- **Stage 1:** Invitation to participate for Physical Education professionals from the rehabilitation sectors of University Hospitals in the EBSEH. Signing of the consent and confidentiality forms and receiving the “*Carta de apresentação do Questionário Inicial aos Profissionais de Educação Física*”. The professionals had 30 days to respond to the Initial Questionnaire “*MoveSUS – Aplicativo de Gerenciamento, Organização e Acompanhamento de Pacientes atendidos nos Setores de Reabilitação dos Hospitais Universitários da*

Rede EBSEH". Following this, the development and creation of the web application commenced.

- **Stage 2:** Experience and use of the MoveSUS web application by Physical Education professionals on their desktop computers, Android, IOS, or iPad mobile/tablet devices within the rehabilitation sector of their affiliated University Hospital. The professionals were invited to participate through the document "*Solicitação de Participação em Pesquisa para Avaliar Usabilidade do Aplicativo MoveSUS*" and had 25 days to test the application.
- **Stage 3:** Utilization of the mHealth Application Usability Questionnaire (MAUQ). This questionnaire was made available after the completion of the 2nd stage of the project.
- **Stage 4:** Data collection from the usability evaluation of the application through responses to the MAUQ.

Development and security overview

The MoveSUS web application was developed using a client-server model, utilizing JavaScript and the Angular 2 framework for front-end development¹¹⁻¹³. The application was hosted on two secure VPS servers from Hostinger. For usability evaluation, only simulated data was used, with no real patient information involved. User passwords were encrypted with BCrypt and securely stored in a MYSQL database. The system hierarchy and development environment are illustrated in Figure 1, which includes the software architecture of the MoveSUS App, the visual studio code layout from the Angular 2 framework, and wireframes depicting the login, patient graphs, and healthcare professional user profiles. More details on this section are provided in the supplementary material.

Data Collection and Questionnaire Review

Usability data for the MoveSUS application were collected using the MAUQ, a standardized tool with 18 affirmatives (S1-S18)¹⁴. This questionnaire was translated and adapted into Portuguese by Medeiros et al.¹⁵, expanding it to 21 affirmatives (D1-D21). The questionnaire assessed three main areas: ease of use, interface/satisfaction, and utility, with responses rated on a Likert scale from 1 (strongly disagree) to 7 (strongly agree). After completing the second stage of the research, Physical Education professionals used the MoveSUS application on various devices and responded to the questionnaire. Some statements were

adapted to fit the professional context in hospitals, and questions 17, 19, 20, and 21 were removed, as they were not applicable to the MoveSUS app's exclusive use by Physical Education professionals.

A preliminary review of the Portuguese MAUQ was conducted by three stakeholders (two Physical Education professionals and one IT professional), along with three target hospital professionals. The feedback confirmed the translation's adequacy and consistency with the original, leading to minor modifications to enhance relevance and applicability without altering the content. These procedures are described in more detail in the supplementary material.

Data analysis and interpretation

All data were analyzed and interpreted using descriptive statistics to obtain the mean \pm standard error, allowing the usability of the application to be measured. The GraphPad Prism 8.0 software was used for descriptive statistics and for plotting bar graphs and heat maps. The heat maps were plotted using a rainbow scale option, where colors range from blue ocean (low scores) to red blood (high scores), with green and pale blue representing intermediate scores. The evaluation scale for the questionnaire responses was a 7-point Likert scale (1 = Strongly Disagree to 7 = Strongly Agree), and average scores were categorized as follows: 1.0–2.9: Low (unsatisfactory), 3.0–4.9: Moderate (needs improvement), 5.0–7.0: High (satisfactory).

Results

The usability of the MoveSUS application was assessed by 14 Physical Education professionals from EBSEH, including 9 women and 5 men, using the MAUQ. The MAUQ was meticulously translated and adapted to the Brazilian context, starting with translation by two independent translators. A committee of specialists, including Physical Education professionals and an IT expert, reviewed and harmonized the translations, followed by back-translation into English to ensure accuracy. The questionnaire was further modified to reflect the specific context of EBSEH university hospitals. A preliminary review by stakeholders ensured clarity and relevance before being administered to the participants (Table 1 and Supplementary Material Table 1).

In the ease of use category, professionals evaluated aspects such as the ease of use of the application, the ease of learning, the consistency in navigating between screens, the ability to use all offered functions, and the

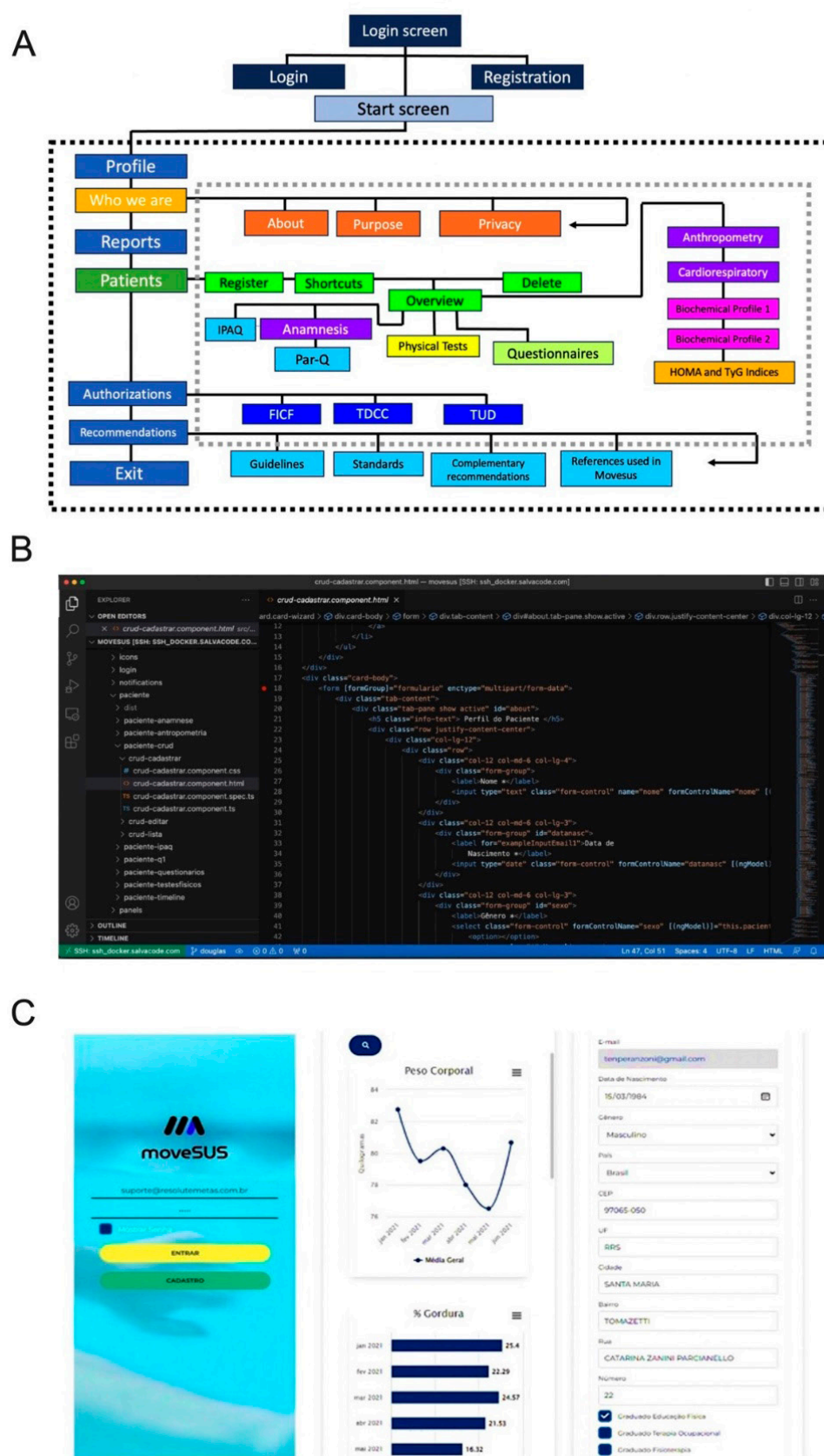


Figure 1 – Software Architecture of the MoveSUS App (Panel B). Visual Studio Code layout running Angular 2 framework (Panel A). Wireframe of introductory animation (login); patient graphs and user profile (healthcare professional) (Panel C).

Table 1 – Table of statements from the original and translated questionnaire

MAUQ Version adapted by Medeiros et al. ¹⁵	Translation
J1. O aplicativo é fácil de usar.	J1. The app is easy to use.
J2. Para mim foi fácil aprender a usar o aplicativo.	J2. It was easy for me to learn how to use the app.
J3. A navegação foi consistente ao mover-se entre as telas. #	J3. The navigation was consistent when moving between screens. #
J4. A interface do aplicativo me permitiu usar todas as funções (como inserir informações ou visualizar informações) oferecidas pelo aplicativo. #	J4. The app's interface allowed me to use all the functions (such as entering or viewing information) offered by the app. #
J5. Sempre que cometia um erro ao usar o aplicativo, conseguia me recuperar com facilidade e rapidez.	J5. Whenever I made a mistake while using the app, I could recover easily and quickly.
J6. Gosto da interface do app.	J6. I like the app's interface.
J7. As informações no aplicativo eram bem organizadas, para que eu pudesse encontrar facilmente as informações de que precisava.	J7. The information in the app was well-organized, so I could easily find what I needed.
J8. O aplicativo reconheceu e forneceu informações de forma adequada para que eu soubesse o andamento de minha ação.	J8. The app acknowledged and provided information adequately for me to know the progress of my actions.
J9. Eu me sinto confortável usando este aplicativo em ambientes profissionais. #	J9. I feel comfortable using this app in professional environments. #
J10. A quantidade de tempo envolvida no uso deste aplicativo foi adequada para mim.	J10. The amount of time involved in using this app was suitable for me.
J11. Eu usaria este aplicativo novamente.	J11. I would use this app again.
J12. No geral, estou satisfeito com este aplicativo.	J12. Overall, I am satisfied with this app.
J13. O aplicativo seria útil para minha prática profissional. #	J13. The app would be useful for my professional practice. #
J14. O aplicativo poderá melhorar meu acesso à prestação de serviços de saúde do meu setor no hospital.	J14. The app could improve my access to health care services in my hospital department.
J15. O aplicativo me ajudou a gerenciar a saúde de meus pacientes com eficiência.	J15. The app helped me efficiently manage my patients' health.
J16. Este aplicativo tem todas as funções e recursos que eu esperava que tivesse.	J16. This app has all the functions and features I expected it to have.
J17. O aplicativo de saúde móvel forneceu uma maneira aceitável de fornecer serviços de saúde, como acessar materiais educacionais, rastrear minhas próprias atividades e realizar autoavaliação.	J17. The mobile health app provided an acceptable way to deliver health services, such as accessing educational materials, tracking my own activities, and performing self-assessment.

ease of recovery in case of errors. The results indicated that the application scored above 6 in some statements (J1 and J2) and above 5 in others (J3, J4, and J5), resulting in an overall average of 5.89 ± 0.34 on a scale of 1 to 7 (Figure 2).

In the interface and satisfaction category, participants evaluated aspects such as the organization of information, comfort in using the application, time spent, and overall satisfaction. The statements showed agreement levels above 6 for aspects such as organization and comfort (J7, J9, J10, J11, and J12), while other statements (J6 and J8) showed partial agreement levels above 5. The overall average for this category was 6.07 ± 0.29 (Figure 3).

In the utility category, professionals evaluated whether the application would be useful for professional practice, whether it would improve the delivery of health services, and whether it would assist in the effective management of patients. Statement J13 achieved the maximum average of 7, with all participants fully agreeing that the application is useful for their practice. Other statements (J14 and J15) indicat-

ed agreement that the application could improve service delivery and patient management, with averages of 6.92 and 6.71, respectively. The overall average for the utility category was 6.35 ± 0.16 (Figure 4).

Discussion

This study discusses the results of the usability evaluation of the MoveSUS application for Physical Education professionals working in the rehabilitation sectors of university hospitals managed by EBSEH. The focus of this research is to understand how the application meets the user's perspective — the Physical Education professional who will use the platform in their daily work — as well as to assess whether it offers a positive impact on the quality of care provided to rehabilitation patients.

Considering that Physical Education Professionals are trained to intervene in the hospital context at primary, secondary, and/or tertiary care levels within the hierarchy recommended by the Ministry of Health and taking into account Unified Health System (*Sistema Único de Saúde* - SUS) guidelines, it is the responsibility

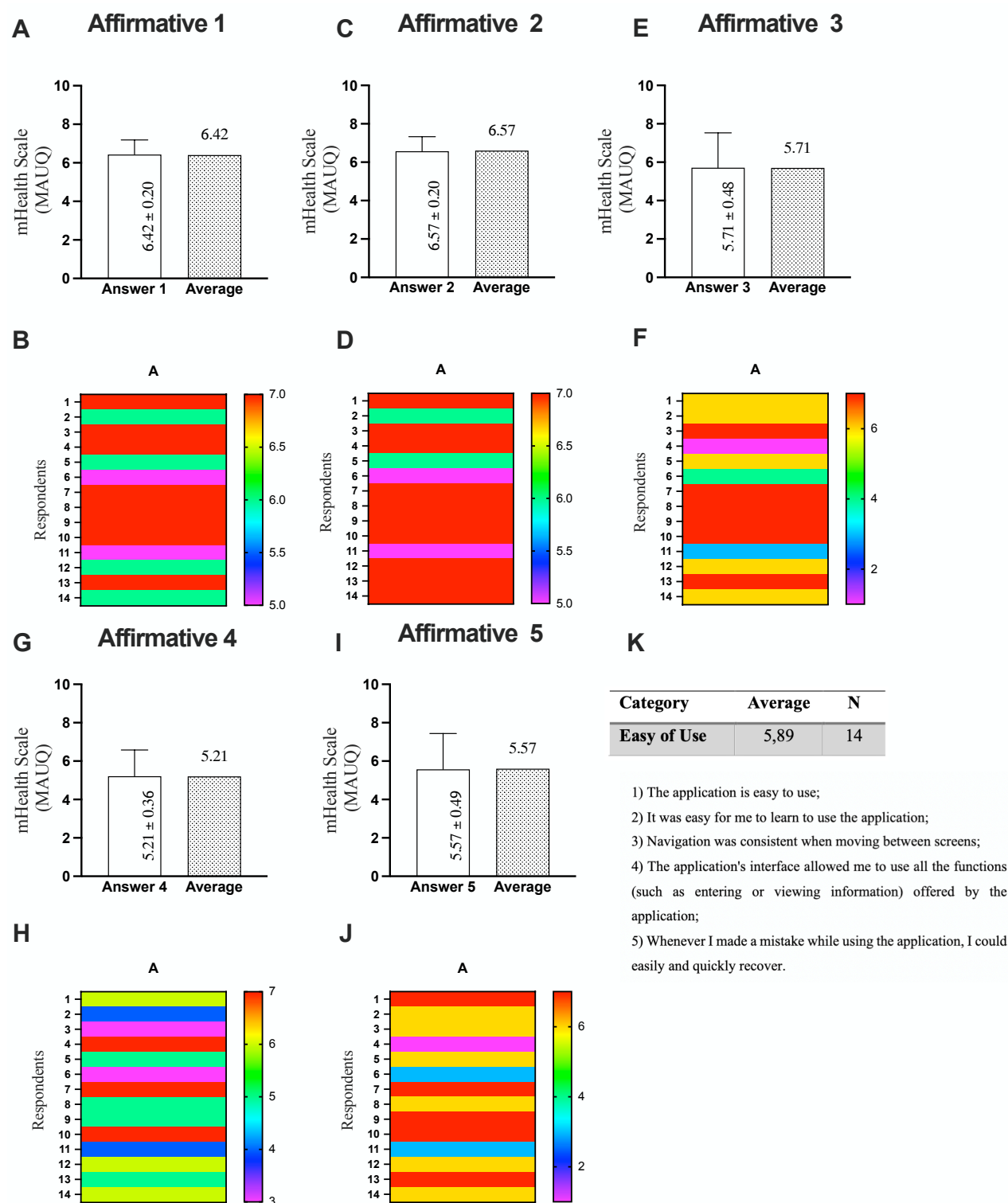


Figure 2 – Average responses for Ease of Use statements. Graphs A, C, E, G, and I show the average for each statement (using a 7-point Likert scale), while B, D, F, H, and J represent corresponding heat maps (in rainbow scale). The heat maps use a color gradient from blue (1.0) to red (7.0), with green as intermediate values. K shows the sum of the statements for the overall average in the Ease of Use category. Each statement is detailed in the figure and Supplementary Material Table 1.

of these professionals in the hospital context to coordinate, plan, program, supervise, direct, organize, evaluate, and execute work, programs, plans, and projects

related to physical activity and exercise. These activities are aimed at promoting, preventing, protecting, educating, intervening, recovering, rehabilitating, treating, and

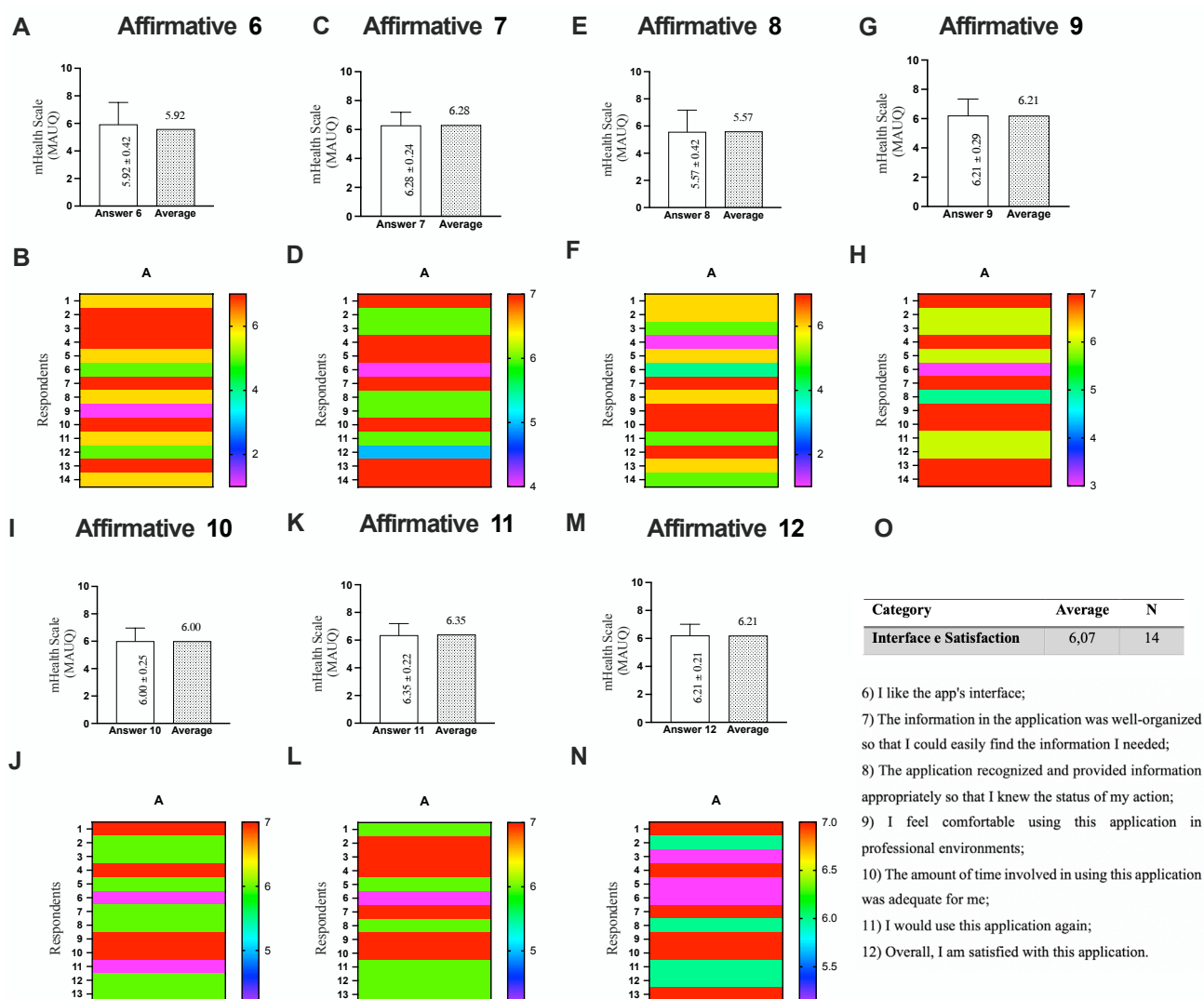


Figure 3 – Average responses for Interface and Satisfaction statements. Graphs A, C, E, G, I, K, and M show the average for each statement (7-point Likert scale), while B, D, F, H, J, L, and N represent corresponding heat maps (in rainbow scale). The heat maps use a gradient from blue (1.0) to red (7.0), with green and pale blue as intermediate values. O shows the sum of the statements for the overall average in the Interface and Satisfaction category. Each statement is detailed in the figure and Supplementary Material Table 1.

providing palliative care for physical and mental health, either specifically or within multidisciplinary and/or interdisciplinary teams^{16,17}. The competencies of Physical Education Professionals in this hospital context can be developed in the areas of “In-Hospital Care” and “Extra-Hospital Care provided by the hospital.”

Science and technology are important tools for health and disease treatment, as well as for constructing a civilizational moment of peace and a dignified and decent life for all¹⁸. The health sector, strongly influenced by the positive science paradigm, has been sensitive to material-type technological incorporations for therapeutic, diagnostic, and life maintenance/improvement purposes, using knowledge and products from informatics, new equipment, and materials¹⁹.

In this study, Physical Education Professionals from the EBSEH evaluated the MoveSUS application, designed for the rehabilitation sector. Using the MAUQ questionnaire, they assessed ease of use, interface and satisfaction, and utility. The results indicated that the MoveSUS web application is easy to use, with users agreeing on its straightforward navigation and functionality (Figure 2). Some Brazilian studies have also evaluated usability aspects, providing suggestions for incorporating technology in health institutions. For instance, the Oncoaudit application, developed to assist nursing professionals in consulting chemotherapeutics as an auditing tool, was validated by nurses and informatics professionals, demonstrating that it meets users' needs²⁰. Another example is the Cuidar Tech applica-

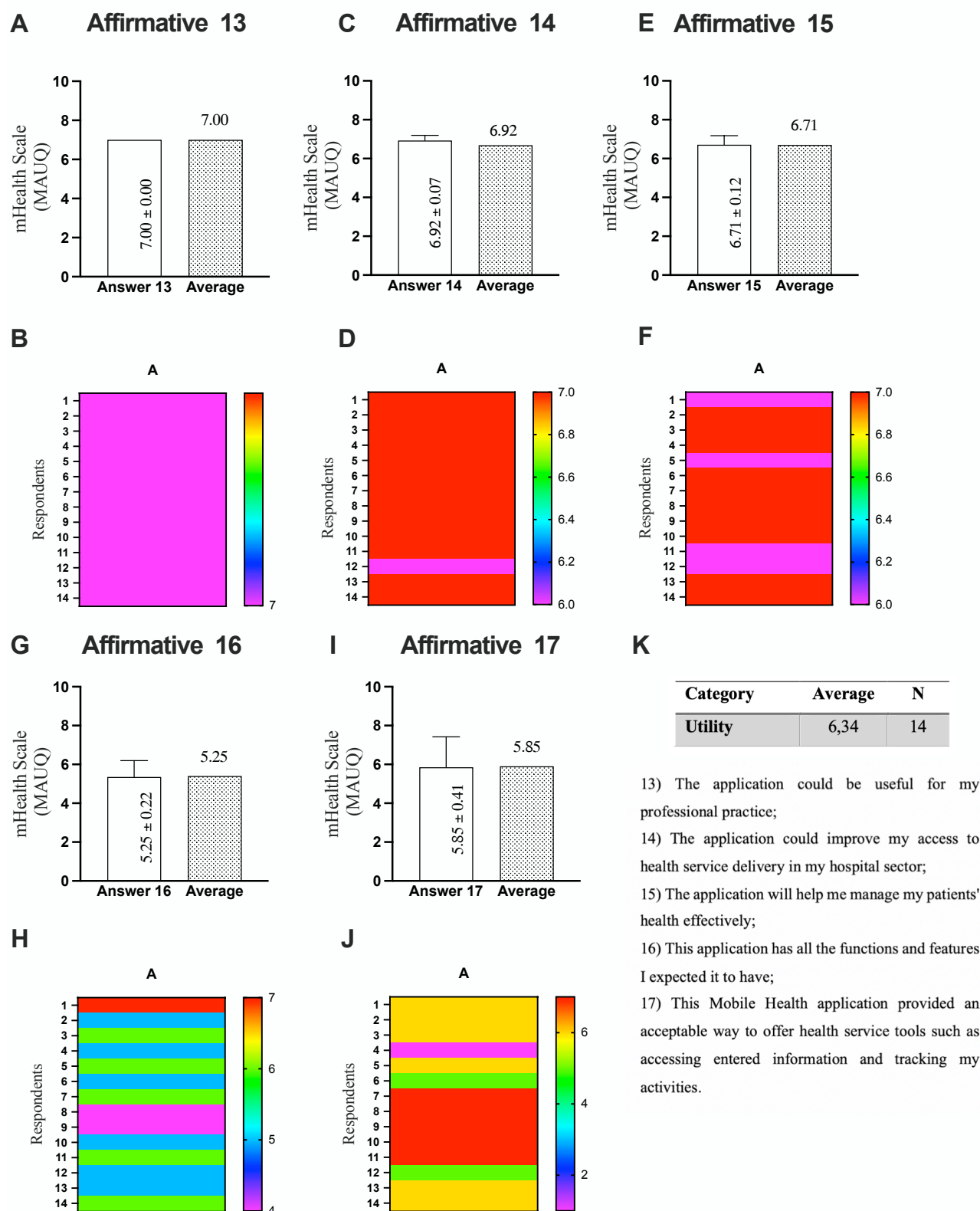


Figure 4– Average responses for Utility statements. Graphs A, C, E, G, and I show the average for each statement (7-point Likert scale), while B, D, F, H, and J represent corresponding heat maps (in rainbow scale). The heat maps use a gradient from blue (1.0) to red (7.0), with green and pale blue as intermediate values. K shows the sum of the statements for the overall average in the Utility category. Each statement is detailed in the figure and Supplementary Material Table 1.

tion, developed to assess and classify the risk of developing diabetes mellitus. This technology was validated by nurses as functional, reliable, adequate, and efficient. Another example was the Cuidar Tech application²¹, developed to assist nurses in assessing and classifying the risk of developing diabetes mellitus by collecting data on the feet of patients with this disease. According to Vescovi et al.²¹, the usability of this technology was evaluated by the app development team and validated by nurses as a functional, reliable, adequate, and efficient app.

The MAUQ responses evaluating the MoveSUS application in the interface and satisfaction category were particularly notable. Physical Education Professionals appreciated the application's interface, found the information well-organized, and were generally satisfied with its performance in professional environments. The overall average for this category was positive, indicating that the application meets the needs of users in these aspects (Figure 3).

Technological innovation in health is defined as the transformation of ideas into products, processes, and technologically new or significantly improved approaches that can potentially provide significant improvements in existing products, processes, and approaches²². Recently, mHealth, have gained significant relevance as tools for healthcare professionals and researchers²³, as well as for monitoring and managing chronic communicable and non-communicable diseases²⁴. According to the Royal Tropical Institute²⁵, there are eight application areas for mHealth apps: i) health promotion and disease prevention; ii) point of care support and diagnosis; iii) user monitoring; iv) real-time infectious disease tracking; v) emergency medical support systems; vi) health information systems; vii) mobile platform for the educational support of health professionals; and viii) health payment/financing app.

mHealth apps have already been used in some research, finding that they are a low-cost, attractive, easily accessible tool with good acceptance by the researched population and suitable for disease control interventions in developing countries²³. According to Blake²⁶, given these characteristics, mHealth apps establish themselves as promising tools for health communication and self-management of diseases. Additionally, they promote dynamic relationships between healthcare professionals, patients, and parent-child interactions.

This class of tools holds great potential for contributing to health promotion and individual care through

various strategies, including hospital management. Regarding the utility of the MoveSUS app, Physical Education Professionals responded positively to statements about the app's usefulness in professional practice, its ability to improve access to health service delivery in hospital sectors, and its effectiveness in managing patient health. The app met expectations in functionality and provided effective tools for tracking and managing activities. With an overall utility score of 6.4 out of 7, professionals agreed that the MoveSUS web application is relevant and valuable for their work routines.

The utilization of MAUQ was fundamental in preliminarily identifying the potential use of MoveSUS in the professional environment of the research participants. It is also necessary to consider that, on one hand, there are numerous apps in virtual stores; on the other hand, there are difficulties in using evaluation instruments in the literature to validate this type of technology. According to Da Silva et al.¹⁹, this occurs, especially due to communication problems—regarding what is intended to be conveyed—between the developer, the app itself, and the end-user. According to Tibes et al.²⁷, measuring the user experience and usability of health apps allows users to achieve specific goals with effectiveness, satisfaction, and efficiency, an important requirement in technology development, which means pointing out easier ways to implement a tool or technological object for these users.

Fang et al.²⁸ conducted a two-arm randomized controlled trial at the First Affiliated Hospital of the Shantou University Medical College, China, evaluating a home-based cardiac telerehabilitation program on low-risk patients after percutaneous coronary intervention. The study included 80 post-percutaneous coronary intervention patients, divided into two groups: the usual care group received paper-based educational materials and biweekly outpatient reviews, while the HBC-TR group engaged in outdoor exercise with real-time physiological monitoring. Results indicated significant improvements in the home-based cardiac telerehabilitation group, particularly in the Six-Minute Walking Test, SF36 Health Survey scores, and Cardiac Depression Scale scores, compared to the usual care group.

The integration of different mHealth applications demonstrates their potential in enhancing healthcare delivery. For instance, the work of Fang et al.²⁸ on programs for coronary heart disease patients highlights how mHealth can support home-based recovery, showing improvements in exercise capacity and mental

health metrics. Similarly, studies by Liang et al.²⁴ on diabetes management and Jordan et al.²⁹ on chronic disease control underline the versatility and effectiveness of mHealth interventions in various health contexts.

This study benefits from a methodology focused on evaluating mobile technologies, whose effectiveness is well-documented, as shown by Widmer et al.²³ and Liang et al.²⁴, demonstrating that mHealth interventions promote exercise adherence, improve the management of chronic conditions, and enhance quality of life. However, an important limitation is that the sample used reflects a specific context of Physical Education professionals in university hospitals managed by EBSEH, which restricts the generalizability of the results to professionals in less structured environments or with fewer technological resources. Additionally, as highlighted by studies such as those by Helbostad et al.⁷ and Slingerland et al.⁸, adherence to and usability of mobile applications can vary significantly according to the work environment and the professional profile. Therefore, factors such as available time for app use, familiarity with digital technologies, and routine hospital demands may have influenced the observed results, indicating the need for future studies in varied contexts. These studies could expand the understanding of the scalability and effectiveness of MoveSUS in different work environments for Physical Education professionals, providing a more comprehensive view of its potential applications in the health sector.

Conclusion

Technological innovation in Brazil's healthcare sector is progressing rapidly, with mobile applications becoming essential tools for healthcare professionals. This study found that the MoveSUS App showed excellent usability, particularly among Physical Education professionals in the EBSEH network, underscoring its suitability and adaptability for professional healthcare environments. The generally positive results on the usability of the app regarding ease of use, interface satisfaction, and utility are evidence of its being helpful to support patient management, monitoring, and rehabilitation. Additionally, MoveSUS has great potential for further integration with the *Aplicativo de Gestão para Hospitais Universitários* (AGHU) App to provide more comprehensive tracking of patients and continuity of care in public healthcare.

Further effectiveness and scalability of the MoveSUS App should also be established in future studies

with larger samples and diverse contexts of application. As more and more mHealth applications are developed, their potential role in health promotion and care is becoming quite promising; hence, ongoing research and development will be necessary to make such tools meet the evolution in demands for healthcare delivery.

Conflict of interest

The authors declare no conflict of interest.

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Author's contributions

Gutierrez JM: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data curation; Supervision; Project administration; Visualization; Funding acquisition; Writing – original draft; Writing – review & editing; Approval of the final version. Peranzoni Junior WE: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Data curation; Project administration; Writing – original draft; Writing – review & editing; Approval of the final version. Oliveira JMS: Software; Validation; Formal analysis; Investigation; Data curation; Project administration; Writing – review & editing; Approval of the final version. Dutra DL: Methodology; Software; Validation; Formal analysis; Resources; Project administration; Writing – review & editing; Approval of the final version. Nunes SSP: Formal analysis; Writing – review & editing; Approval of the final version. Gheno EM: Formal analysis; Resources; Writing – review & editing; Approval of the final version.

Declaration regarding the use of artificial intelligence tools in the article writing process

The authors did not use artificial intelligence tools for preparation of the manuscript.

Availability of research data and other materials

The contents underlying the research text are contained in the manuscript.

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Supplementary Material 01

Technologies used in web software development

The development of web applications can follow methodologies similar to those used for other platforms¹. As web applications are based on the client-server model, they utilize front-end technologies (executed in the browser) and back-end technologies (executed on the server), with interactions performed via HTTP requests through the web browser. The front-end technology employed includes the JavaScript programming language. When the client makes an HTTP request to a web system, server software collects the request information, processes it on the back-end, and sends the response to the front-end². JavaScript is a language for creating front-end scripts that interact with web pages and browser behavior, enabling manipulation of the

HTML document in a tree structure called the Document Object Model (DOM), handling events, loading remote content via AJAX, and altering CSS rules. For this application, the Angular 2 platform was utilized, an open-source JavaScript framework maintained by Google for building Single Page Applications (SPA). The system hierarchy of the application is presented in Figure 2.

Security, Encryption, and Hosting in Application Usage

All information collected in the MoveSUS application was entered by Physical Education professionals. The web application was hosted on two VPS (Virtual Private Server) servers from Hostinger for multiple users. For the usability evaluation, no personal patient information was used; instead, simulated data was employed

Table 1 – Table of statements from the original and translated questionnaire

Zhou et al. ³	Medeiros et al. ⁴	Authors
S1. The app was easy to use.	D1. O aplicativo foi fácil de usar.	J1. O aplicativo é fácil de usar.
S2. It was easy for me to learn to use the app.	D2. Foi fácil de aprender a usar o aplicativo.	J2. Para mim foi fácil aprender a usar o aplicativo.
S3. The navigation was consistent when moving between screens.	D12. A navegação era consistente ao se mover entre as telas.	J3. A navegação foi consistente ao mover-se entre as telas. #
S4. The interface of the app allowed me to use all the functions (such as entering information, responding to reminders, viewing information) offered by the app	D13. A interface do aplicativo me permitiu usar todas as funções oferecidas pelo aplicativo.	J4. A interface do aplicativo me permitiu usar todas as funções (como inserir informações ou visualizar informações) oferecidas pelo aplicativo. #
S5. Whenever I made a mistake using the app, I could recover easily and quickly.	D9. Sempre que cometi um erro ao usar o aplicativo, eu me recuperava com facilidade e rapidez.	J5. Sempre que cometia um erro ao usar o aplicativo, conseguia me recuperar com facilidade e rapidez.
S6. I like the interface of the app.	D3. Eu gosto da interface do aplicativo.	J6. Gosto da interface do app.
S7. The information in the app was well organized, so I could easily find the information I needed.	D4. As informações no aplicativo foram bem organizadas.	J7. As informações no aplicativo eram bem organizadas, para que eu pudesse encontrar facilmente as informações de que precisava.
S8. The app adequately acknowledged and provided information to let me know the progress of my action.	D11. O aplicativo reconheceu e forneceu informações adequadamente para que eu saiba o andamento de minha ação.	J8. O aplicativo reconheceu e forneceu informações de forma adequada para que eu soubesse o andamento de minha ação.
S9. I feel comfortable using this app in social settings.	D5. Sinto-me confortável ao usar este aplicativo em ambientes sociais.	J9. Eu me sinto confortável usando este aplicativo em ambientes profissionais. #
S10. The amount of time involved in using this app has been fitting for me.	D6. A quantidade de tempo envolvida no uso deste aplicativo foi adequada para mim.	J10. A quantidade de tempo envolvida no uso deste aplicativo foi adequada para mim.
S11. I would use this app again.	D7. Eu usaria este aplicativo novamente.	J11. Eu usaria este aplicativo novamente.
S12. Overall, I am satisfied with this app.	D8. No geral, estou satisfeito com este aplicativo	J12. No geral, estou satisfeito com este aplicativo.
S13. The app would be useful for my health and well-being.	D15. O aplicativo seria útil para minha prática de assistência médica.	J13. O aplicativo seria útil para minha prática profissional. #
S14. The app improved my access to health care services.	D16. O aplicativo melhorou meu acesso à prestação de serviços de saúde.	J14. O aplicativo poderá melhorar meu acesso à prestação de serviços de saúde do meu setor no hospital.
S15. The app helped me manage my health effectively.	D17. O aplicativo me ajudou a gerenciar a saúde de meus pacientes com eficiência.	J15. O aplicativo me ajudou a gerenciar a saúde de meus pacientes com eficiência.
S16. This app has all the functions and capabilities I expected it to have.	D14. Este aplicativo tem todas as funções e capacidades que eu esperava que ele tivesse.	J16. Este aplicativo tem todas as funções e recursos que eu esperava que tivesse.
S18. This mHealth app provided an acceptable way to receive health care services, such as accessing educational materials, tracking my own activities, and performing self-assessment.	D18. O aplicativo facilitou a comunicação com meus pacientes.	J17. O aplicativo de saúde móvel forneceu uma maneira aceitável de fornecer serviços de saúde, como acessar materiais educacionais, rastrear minhas próprias atividades e realizar autoavaliação.

to create a realistic experience for the Physical Education professional. User passwords on the platform were encrypted and protected by the BCrypt generator, with storage in MySQL.

Study Population and Group

The study population consisted of Physical Education professionals from the rehabilitation sectors of the 41 University Hospitals in the Brazilian Company of Hospital Services (*Empresa Brasileira de Serviços Hospitalares* – EBSEH) network. All professionals were invited to participate in the project through an “Invitation and Presentation Letter.” Additionally, all participants signed an Informed Consent Form (ICF) and a Confidentiality Agreement (CA) before participating in the presentation of the project stages and the Initial Questionnaire. All professionals were invited to voluntarily participate in the study; however, we received 27 responses to the Initial Questionnaire “MoveSUS – Application for Management, Organization, and Monitoring of Patients in the Rehabilitation Sectors of the University Hospitals in the EBSEH Network.” These responses were used to identify the technological needs and the reality of Physical Education professionals working in the rehabilitation sectors of the University Hospitals in the EBSEH network, as well as to guide the creation and initial development of the MoveSUS application.

Usability data for the MoveSUS web application were collected from responses to the Mobile Health Application Usability Questionnaire (MAUQ), a standardized instrument for this type of research. Fourteen (14) responses were obtained, with 9 female and 5 male Physical Education professionals, from 8 University Hospitals in the Northeast region of Brazil, 2 from the Midwest region, 2 from the Southeast region, and 2 from the South region of the country.

Data collection procedures

Usability data for the application were collected through responses to the Mobile Health Application Usability Questionnaire (mHealth MAUQ), a standardized instrument for this type of research with 18 affirmatives (S1-S18)³. This questionnaire was translated and adapted to Portuguese by Medeiros et al.⁴ with 21 affirmatives (D1-D21). The questionnaire included statements distributed into three parts: ease of use, interface/satisfaction, and utility. MAUQ used a Likert scale for evaluation, with responses ranging from: 1 -

strongly disagree, 2 - disagree, 3 - somewhat disagree, 4 - neither agree nor disagree, 5 - somewhat agree, 6 - agree, and 7 - strongly agree.

This questionnaire was administered after the completion of the 2nd stage of the research project, during which Physical Education professionals experienced, navigated, and used the MoveSUS application on their desktop computers, Android, iOS, or iPad mobile/tablet devices. They responded to statements distributed into three parts: ease of use (statements 1 to 5), interface and satisfaction (statements 6 to 12), and utility (statements 13 to 17). Stakeholders removed question 17, 19, 20 and 21 from the Portuguese MAUQ questionnaire, since the MoveSUS app was exclusively directed towards Physical Education professionals without direct interaction with patients. Additionally, statements 4, 9, 13, 14 and 17 were adapted to refer to “ambiente profissional” (English: “professional environment”), “prática profissional” (English: “professional practice”), “meu setor no hospital” (English: “my sector in the hospital”) (Table 1).

Review and feedback from stakeholders

Preliminarily, three stakeholders (2 Physical Education professionals and 1 IT professional) along with three members of the target professionals of hospitals reviewed the Portuguese MAUQ questionnaire and confirmed that the content was clear, understandable, and relevant. This initial feedback suggested that the translation was adequate and that the items in the questionnaire were interpreted consistently with the original version with minor modifications. These adaptations were made to ensure that the questionnaire is more relevant and applicable to the specific context of Physical Education professionals in hospitals without modifying its content (J1-J17).

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