Usability evaluation of a multidisciplinary mobile application for the education and management of pre and postoperative bariatric surgery patients

Avaliação de usabilidade de um aplicativo móvel multidisciplinar para a educação e gestão de pacientes em pré e pós-operatório de cirurgia bariátrica

Evaluación de usabilidad de una aplicación móvil multidisciplinaria para la educación y gestión de pacientes de cirugía bariátrica pre y postoperatoria

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ABSTRACT

Objective: To assess the usability of a mobile application prototype for educating and managing individuals undergoing bariatric surgery. **Methods:** An exploratory quantitative study was conducted at a public outpatient obesity referral center in Brazil. Pre- and postoperative bariatric surgery patients were invited to use of an app for one hour, and its usability was assessed through the System Usability Scale (SUS). **Results:** Of the 31 participants, 84.0% were women, with a mean age of 42.2 (±12.4) years. Most participants (97.0%) had high or primary school education levels. Of the total sample, 12 (38.8%) were preoperative and 19 (61.2%) postoperative. The mean overall usability score for the app was 75.5 (SD 11.0). Participants rated usability as "Good" (34.2%), "Excellent" (51.4%), and "Best Achievable" (14.4%). No significant difference in usability scores was found across different educational backgrounds (p 0.654) and income levels (p 0.088), except for a statistically significant difference between younger and older adults (p 0.014). **Conclusion:** The app was considered useful by obese patients as a tool for learning and helping navigate bariatric care.

Keywords: Mobile health, Bariatric surgery, Educational technology.

RESUMO

Objetivo: Avaliar a usabilidade de um protótipo de aplicativo móvel para educar e gerenciar indivíduos submetidos à cirurgia bariátrica. **Métodos:** Estudo exploratório quantitativo realizado em um ambulatório público especializado em obesidade no Brasil. Pacientes em pré e pós-operatório de cirurgia bariátrica foram convidados a usar o aplicativo por uma hora e avaliaram sua usabilidade através da Escala de Usabilidade do Sistema (SUS). **Resultados:** Dos 31 participantes, 84,0% eram mulheres, com idade média de 42,2 (±12,4) anos. A maioria dos participantes (97,0%) possuía níveis de escolaridade fundamental ou médio. Da amostra total, 12 (38,8%) estavam no pré-operatório e 19 (61,2%) no pós-operatório. A pontuação geral média de usabilidade do aplicativo foi de 75,5 (DP 11.0). Os participantes classificaram a usabilidade como Boa (34,2%), Excelente (51,4%) e Melhor Possível (14,4%). Não foi encontrada diferença significativa nos escores de usabilidade entre diferentes níveis educacionais (p 0,654) e níveis de renda (p 0,088), exceto por uma diferença estatisticamente significativa entre adultos mais jovens e mais velhos (p 0,014). **Conclusão:** O aplicativo foi considerado útil pelos pacientes obesos como uma ferramenta para aprendizado e auxílio na navegação pelos cuidados bariátricos.

Palavras-chave: Telemedicina, Cirurgia bariátrica, Tecnologia educacional.

RESUMEN

Objetivo: Evaluar la usabilidad de un prototipo de aplicación móvil para educar y gestionar a personas que se someten a cirugía bariátrica. **Métodos:** Estudio cuantitativo exploratorio realizado en un centro ambulatorio público especializado en obesidad en Brasil. Se invitó a pacientes en pre y postoperatorio de cirugía bariátrica a usar la aplicación durante una hora y evaluaron su usabilidad mediante la Escala de Usabilidad del Sistema (SUS). **Resultados:** De los 31 participantes, el 84,0% eran mujeres, con una edad media de 42,2 (±12,4) años. La mayoría de los participantes (97,0%) tenía niveles de educación primaria o secundaria. De la muestra

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total, 12 (38,8%) estaban en el preoperatorio y 19 (61,2%) en el postoperatorio. La puntuación media de usabilidad general de la aplicación fue de 75.5 (DE 11.0). Los participantes calificaron la usabilidad como Buena (34,2%), Excelente (51,4%) y Mejor Posible (14,4%). No se encontró una diferencia significativa en los puntajes de usabilidad entre diferentes niveles educativos (p 0.654) y niveles de ingresos (p 0.088), excepto por una diferencia estadísticamente significativa entre adultos jóvenes y mayores (p 0.014). **Conclusión:** Los pacientes obesos consideraron que la aplicación es útil como herramienta de aprendizaje y para ayudar a navegar por el cuidado bariátrico.

Palabras clave: Telemedicina, Cirugía bariátrica, Tecnología educacional.

INTRODUCTION

Obesity is a major public health problem with a prevalence estimated at around 40% among adults (QADAR SMZ, et al., 2024). Bariatric surgery is considered the most effective treatment for morbid obesity, offering significant potential for substantial weight reduction (PIPEK LZ, et al., 2024). However, the long-term outcomes of bariatric surgery are influenced by factors such as adherence to lifestyle modifications, comprehensive support before and after surgery, management of comorbidities, and ongoing follow-up care (REMMEL S, et al., 2024; SCHWOERER A, et al., 2017). In particular, several authors highlight the importance of educating patients to engage in self-care actively (SERRANO-FUENTES N, et al., 2024).

Effective self-management post-bariatric surgery involves strong health literacy, increased healthcare engagement, and timely lifestyle adjustments (HECHT L, et al., 2019; MAHONEY ST, et al., 2018). Regular postoperative follow-up is a crucial element for successful weight management after bariatric surgery, with research consistently highlighting its positive influence on long-term outcomes. Patients adhering to regular follow-up appointments achieved more significant weight loss, underscoring the value of consistent postoperative care in optimizing results (SCHWOERER A, et al., 2017). However, despite its importance, follow-up adherence remains a significant challenge, often leading to suboptimal patient outcomes.

In response to this, digital health tools have emerged as a promising solution, offering patients continuous support throughout their postoperative journey. These tools aim to enhance follow-up adherence, thereby improving long-term weight loss success. The use of mobile applications for education in the context of bariatric surgery has shown significant benefits in several areas. Studies indicate that smartphone apps can be effective in preoperative preparation, promoting positive behavioral changes, and enhancing weight loss outcomes (MUNDI MS, et al., 2015). Additionally, these apps can improve adherence to perioperative protocols and reduce the need for emergency room visits, as reported by patients who utilized an app for home recovery support (HEUSER J, et al., 2021).

Despite the growing number of mobile health (mHealth) apps, the reporting of usability testing results remains limited, underscoring the importance of rigorous evaluation before widespread adoption (AZAD-KHANEGHAH P, et al., 2020). The widespread use of mobile devices represents a significant opportunity for improving patients' health literacy (DIAS V, FILHO H, 2023). mHealth apps offer the potential to provide easy and personalized access to evidence-based health information and education, particularly benefiting individuals with low health literacy (LIU P, et al., 2020). Our study assessed a mHealth app in Brazil to aid patients undergoing bariatric surgery and enhance health literacy. A multidisciplinary team designed the app's prototype, but its usability must still be assessed.

Usability is critical in evaluating the user's experience with a mHealth app and assessing how easily end-users can interact with the system (WHO, 2016). The availability of mobile apps is expanding rapidly. Gamified mHealth technologies represent a significant advancement in learning methods (ARIF YM, et al., 2024) and in delivering educational and motivational content to bariatric surgery patients, especially those encountering significant care barriers (ROWLAND SP, et al., 2020), offering a more practical alternative to websites (DIAS V, FILHO H, 2023).

Given the complexity of user interaction with mobile apps, usability has become a focal point in human-computer interaction studies. Well-designed apps can profoundly impact the user experience, improving patient outcomes (NIELSEN J, MACK RL, 1994; PÁDUA CIPS, 2012). Usability testing plays a crucial role in

the development and implementation of new medical devices, ensuring their intended users can use them safely and effectively.

This testing process is vital for gaining clinical adoption (BELTZER A, et al., 2024). Usability testing examines user-device interactions to identify and resolve potential errors that may affect the device's safety and functionality. This process reveals important challenges related to ease of handling and clarity of instructions, both of which are crucial for the device's overall effectiveness and user satisfaction (MURRA LP, MACE CR, 2020).

In the development of point-of-care devices, usability testing helps bridge the gap between academic research and practical application, with user feedback driving necessary design refinements for effective real-world use. This iterative process ensures safer, user-friendly designs by identifying and addressing use errors early on (CARON A, et al., 2022). This study assessed the usability of a prototype app designed to educate and manage individuals undergoing bariatric surgery, aiming to advance tools that contribute positively to long-term health outcomes in this patient population.

METHODS

Study design and setting

This is a single-center exploratory study to assess the usability of the mHealth app prototype. The study was conducted at a referral center for obese individuals at Santa Casa Belo Horizonte (CEM-SCBH) in Belo Horizonte, Brazil, between September 2023 and January 2024. It received approval from the Research Ethics Committee of Santa Casa Belo Horizonte (CAAE: 87762218600005138; Opinion Number: 2.713.261) and all participants signed informed consent.

Participants

Participants were chosen based on the app's target user population being evaluated. The study included preoperative and postoperative bariatric surgery outpatients to provide a comprehensive assessment of usability, who owned smartphones aged ± 18 years. Individuals without criteria for bariatric surgery were excluded from the study.

Procedures

Forty-five patients waiting for their clinical appointment at CEM-SCBH were invited to participate. Thirty-one patients agreed to participate and were enrolled in the study. The participants received in-person instructions on downloading and navigating and were allowed to use the app for one hour while waiting for their consultation. After experiencing the app, the participants answered an online version of the System Usability Scale (SUS).

The SUS is a widely used tool for assessing system usability and is versatile across all stages of app development (ENSINK CJ, et al., 2024; SILVA LVF da, et al., 2021). The SUS consists of 10 statements that should be answered using a 5-point Likert scale. The items cover various aspects of usability, such as satisfaction, efficiency, ease of use, and learnability in using the system. The items are (BROOKE J, 1996; JOSHI A, et al., 2015):

1. I think that I would like to use this system frequently.

2. I found the system unnecessarily complex.

3. I thought the system was easy to use.

4. I think that I would need the support of a technical person to be able to use this system.

5. I found the various functions in this system were well-integrated.

6. I thought there was too much inconsistency in this system.

7. I would imagine that most people would learn to use this system very quickly.

8. I found the system very cumbersome to use.

9. I felt very confident using the system.

10. I needed to learn many things before I could get going with this system.

Items 1, 3 (ease-of-use), 5, 7 (learnability), and 9 (confidence-in-use) are positively worded, while items 2 (perceived complexity), 4 (learnability), 6 (consistency), 8, and 10 are negatively worded. A lower rate for the negatively oriented items indicates a more positive user perception.

Statistical analysis

After data collection, the usability overall score was calculated by multiplying the score by 2.5, resulting in a scale from 0 to 100 points. The results can be classified into five categories: 13 to 20.5 (worst imaginable); 21 to 38.5 (poor); 39 to 52.5 (median); 53 to 73.5 (good); 74 to 85.5 (excellent); and 86 to 100 (best imaginable) (BORGES AP, et al., 2021; BROOKE J, 1996). As a rule of thumb, 68 is the average SUS score. This score provides a quantitative measure of the system's usability (BROOKE J, 1996). The nonparametric Mann-Whitney test was used to compare SUS scores between individuals from different educational backgrounds and income level. In contrast, the nonparametric Kruskal-Wallis test was utilized to determine whether there were differences in the median SUS scores across the age groups.

RESULTS

The study was carried out between August 2023 and January 2024. The participants assessed a multidisciplinary mobile app incorporating gamification to help pre- and post-operative bariatric surgery patients navigate care. Forty-five individuals were recruited from CEM-SCBH. Thirty-one participants were enrolled, all of whom successfully completed the usability test. No participants dropped out of the study. Most of the individuals, 26 (84.0%), were women. Predominant age groups were between 40 and 50 years old (48.4%) and under 40 years (38.7%). Among the total sample, 12 (38.8%) were preoperative, and 19 (61.2%) were postoperative individuals. The average BMI for preoperative bariatric surgery patients was 49.4 kg/m², whereas postoperative patients had an average BMI of 35.3 kg/m². Most participants were submitted to the surgery 1 to 2 years prior (55.5%), followed by those who had surgery 2 to 3 years prior (22.2%). All participants possessed smartphones, and 23 (74.1%) had previously used apps to track their weight. Participants' sociodemographic characteristics are shown in (**Table 1**).

Table 1 – Participants' sociodemographic characteristics.

Variables	N	%
Average monthly income (Brazilian minimum wage)		
Under 1	4	12.9%
1	17	55.5%
1 to 2	7	22.3%
Over 2	3	9.3%
Educational level		
Primary school	16	51.6%
High school	14	45.2%
College	1	3.2%
Postoperative participants' type of surgery		
Gastric bypass	18	95.0%
Sleeve gastrectomy	1	5.0%
Comorbidities		
Yes	23	75.0%
Hypertension (82.0%)		
Diabetes mellitus (48.2%)	-	
Arthropathies (14.3%)		
No	8	25.0%

Source: Gonçalves BC, et al., 2025.

The overall usability score was 75.5. After the categorization of the scores, 9 (29.0%) of the participants rated the app as Good, 18 (58.0%) as Excellent, and 4 (12.9%) as Best Achievable. The benchmarks for the SUS items, which correspond to the overall SUS benchmark score of 68 (representing an average system score), were calculated and presented as the median, 25th percentile, and 75th percentile. Specifically, for Item 1, the median SUS score was 4.0 (range: 4.0-5.0); for Item 2, the median was 2.0 (range: 2.0-3.5); for Item 3, the median was 4.0 (range: 4.0-5.0); and for Item 4, the median was 2.0 (range: 1.0-3.0). Analysis of the SUS scale items revealed that the majority was well-rated. Items 8 and 10 received exceptionally high rates, indicating strong user perceptions in these areas.

Scores for items 1, 3, 4, 5, 6, 7, and 9 reflected generally positive evaluations. Our analysis found no significant association between SUS scores and the level of education. Specifically, patients with primary education exhibited median scores comparable to those with a high school education or higher: 76.2 (SD 12.6) vs. 77.5 (SD 9.3); p = 0.654. Furthermore, no statistically significant difference in median SUS scores was identified between individuals earning one or less versus more than 1 Brazilian minimum wage: 75.0 vs. 77.5; p = 0.088. Age group analysis revealed that participants under 40 years of age had significantly higher median SUS scores (82.5; IQR 12.5) compared to those aged 40-50 years (75.0; IQR 5.0) and those over 50 years (72.5; IQR 15.0); p = 0.014 (**Table 2**).

Table 2 - Descriptive Statistics of SUS Scores by Age and Education Level Group.

Variable	N	Md	Min	Max	p-value
Age group (years)					
< 40	12	82.5 (78.7, 91.2)	50.0	100.0	0.014[a]
40 to 50	13	75.0 (72.5, 77.5)	67.5	95.0	
> 50	6	72.5 (60.0, 75.0)	55.0	77.5	
Education level group					
Primary school	16	76.2 (70.0, 81.2)	50.0	100.0	0.654[b]
High school	15	77.5 (70.0, 82.5)	60.0	95.0	

Note: [a] Kruskal-Wallis test; [b] Mann-Whitney test. Multiple comparison only < 40 versus > 50 years significant p = 0.018. N = Valid N; Md = Median (percentile 25, 75); Min = Minimum; Max = Maximum.
Source: Gonçalves BC, et al., 2025.

DISCUSSION

The app was deemed useful by its target users, with its multidisciplinary approach being a key feature, especially important in managing obese patients. Most participants rated the usability as excellent, suggesting high overall usability for an early-stage prototype. Usability measurement is critical for understanding user interactions, objectives, and the activities that users are expected to perform. The number of usability studies has grown significantly in recent years (SILVA LVF da, et al., 2021), highlighting the importance of early evaluations to minimize the cost of changes (NIELSEN J, MACK RL, 1994). The app usability testing was seamlessly integrated into its development, ensuring user's feedback was effectively incorporated.

Usability assessment through questionnaires has been the most prevalent method, compared to other approaches such as task completion tests, interviews, and heuristic evaluations. (MARAMBA I, et al., 2019). This study evaluated a mHealth usability using the SUS questionnaire, focusing on clinical settings involving preoperative and postoperative bariatric surgery patients. The SUS is widely used to assess user satisfaction and interaction with a system, offering valuable insights into its overall usability. By evaluating the 10 items, the SUS provides a holistic view of an app's usability, encompassing satisfaction, efficiency, ease of use, and learnability.

Together, these elements offer a comprehensive understanding of how users perceive and interact with the app, which can significantly impact its long-term success (LEWIS JR, SAURO J, 2018; YANG C, et al., 2022). Like most previous usability studies, our study involved a sample of 20 to 50 participants, sufficient to conduct a usability assessment (SILVA LVF da, et al., 2021). The app received an SUS score of 75.5, surpassing the benchmark of 68 for digital health apps (HYZY M, et al., 2022; LEWIS JR, SAURO J, 2018),

indicating positive user's feedback. The app graded 'B' on the Sauro-Lewis curved grading scale, corresponding to a 70 to 79 percentile range, and indicating a positive user experience (LEWIS JR, SAURO J, 2018).

The app performed well in most usability domains, though there is room for improvement. This grade suggests that users found the app usable, effective, and satisfying, but some minor issues may still affect specific aspects of the experience. Streamlining workflows and improving user support, to further enhance usability offer opportunities for refinement. While some users found the system challenging to navigate, they reported ease in data input and correction, effective error management, and overall satisfaction with the app's alignment with user's needs. Despite the short evaluation period, the app demonstrated promising usability results, consistent with findings from similar studies in the literature (YANG C, et al., 2022). Previous research indicates that users' perceptions of usability tend to improve over time as they become more familiar with the system (VLACHOGIANNI P, TSELIOS N, 2021).

This suggests that the app usability, already well-received in its initial stages, is likely to improve further as users continue to engage with the app, enhancing its effectiveness in meeting the needs of bariatric patients. App usability is significantly influenced by factors such as the app's purpose, user needs, and expectations (ALTURKI R, GAY V, 2019).

The mHealth app, esigned to support individuals undergoing bariatric surgery, clearly serve the functional goals of users, such as tracking dietary intake, managing physical activity, and providing educational resources about post-surgery care. Furthermore, the app is intuitive and tailored to meet these needs, thereby promoting continuous app engagement. Its cultural adaptation likely enhanced both acceptability and effectiveness (HARPER SHEHADEH M, et al., 2016).

Additionally, incorporated gamification elements could improve user learning, engagement, and cooperation (KRISHNAMURTHY K, et al., 2022). The app offers an accessible and intuitive experience, making it easier for patients to adhere to the platform. This is crucial in a bariatric context, where continuity of care and remote follow-up are key to the success of the procedure and the long-term maintenance of results. We also found no significant difference in usability scores between participants from different educational backgrounds, aligning with a systematic review assessing the usability of mobile applications and internet platforms (VLACHOGIANNI P, TSELIOS N, 2021). We expected differences, as users with primary education may prioritize simplicity, while those with higher education might appreciate more advanced features (WAI I, et al., 2018; KRISHNASAMY T, 2021).

Similarly, no significant variation in SUS scores was observed across different income levels and major age groups, except for a statistically significant difference between younger and older adults, with the latter facing more challenges in adopting certain app features. Older users (50+) scored lower on the SUS, consistent with previous research evaluating a website prototype for pension and health insurance information (CHADWICK-DIAS A, et al., 2002). Age can influence usability testing outcomes, with younger adults generally outperforming older adults, particularly in task completion time when using input devices such as touchscreens and keyboards (SONDEREGGER A, et al., 2016). Several factors contribute to these differences, including social, cognitive, psychological, and physical aspects and variations in life experience with technology devices (CHADWICK-DIAS A, et al., 2002).

The app final version was designed to address users' needs, critical to ensuring its success and widespread adoption. Key usability characteristics such as ease of use, consistency, and error management were prioritized to enhance the user experience. By focusing on these usability principles, the app can cater to diverse users, helping them achieve their goals while minimizing frustration and maximizing efficiency (WEICHBROTH P, 2020). One of the SUS items assesses user satisfaction by measuring willingness to engage with the system regularly, reflecting perceived value and comfort (YANG C, et al., 2022).

This question is crucial, as frequent use indicates the system's relevance and a positive user experience (LEWIS JR, SAURO J, 2018; BORGES AP, et al., 2021). As the app users become more familiar with the system, they will likely experience increased comfort and efficiency, leading to a more favorable perception of

its overall value. Moreover, consistent engagement may reveal additional features and benefits, boosting satisfaction. This positive feedback loop underscores the importance of encouraging users to interact with the app more frequently, as it can foster a deeper connection with the platform and enhance the overall user experience.

The SUS questionnaire also addresses ease of use, and such characteristics are central to positive user experiences, allowing users to navigate tasks without frustration (LEWIS JR; SAURO J, 2018). The app high score in this item correlates with increased satisfaction and adoption of the app. The app also showed a high score related to learnability, an indicator of how easily users can operate the app without external assistance. This suggests that users can quickly become proficient, enhancing the likelihood of sustained engagement. Systems requiring minimal external support are perceived as more user-friendly, fostering a sense of independence in users (YANG C, et al., 2022).

On the other hand, lower scores were observed in the item 2 related to app complexity, with a mean score of 2.6 (SD 1.1). Complex systems hinder efficiency by creating unnecessary barriers to task completion (LEWIS JR, SAURO J, 2018). We expect that the perception of complexity will improve over time as users become more familiar with the app's functions (VLACHOGIANNI P, TSELIOS N, 2021). The findings indicate areas for improvement in system design, such as simplifying complexity and enhancing features for a smoother user experience. The short evaluation period may limit users' ability to assess all resources from the app. Increased usage, better health, and digital literacy could lead to even better outcomes. The key challenge is designing tools that evoke the desired user's perceptions and emotions while ensuring usefulness and ease of use.

The strong usability results demonstrate that the app adds significant value to the bariatric process by providing educational materials, monitoring health parameters, and offering reminders for medication and appointments, which promotes greater patient engagement. Additionally, the app can help lower postoperative complication rates by enabling patients to track their progress and report potential issues in real-time. This leads to increased peace of mind for patients, who feel more supported and informed through an easy-to-use and learnable educational system, and for the medical team, which can intervene early when necessary.

By reducing exclusive dependence on in-person consultations, the app can contribute to the decentralization of care without compromising the quality of monitoring. This continuous digital support strengthens health education, which is one of the pillars of bariatric surgery, as inadequate understanding of postoperative care can jeopardize expected outcomes. Postoperative follow-up is essential for ensuring successful outcomes after bariatric surgery, as it helps manage complications, supports weight loss maintenance, and monitors nutritional status. The use of mobile applications presents an innovative solution to improve adherence to long-term follow-up. Many patients fail to maintain regular follow-ups in the years after surgery, which can lead to suboptimal outcomes (SCHWOERER A, et al., 2017).

A validated and usability-tested mobile app can bridge this gap by offering easy access to follow-up resources, reminders for medical visits, and ongoing support. The app aims to increase patient engagement, reduce attrition, and support postoperative care, contributing to improved long-term success after bariatric surgery. The study's limitations include its single-center setting, similar to previous studies (O'MALLEY G, et al., 2014). Additionally, Our study represents the initial usability test for the system, consistent with prior research (LEE JY, et al., 2019; YANG C, et al., 2022). However, the sample size is not regarded as a limitation (SILVA LVF da, et al., 2021).

CONCLUSION

The mHealth app was user-friendly and suitable for providing self-care information and helping patients undergoing bariatric surgery to navigate into care. The app SUS score, surpassing the benchmark for digital health apps, further confirms its utility in enhancing patient outcomes, especially as familiarity with the app grows over time. With improvements in complexity and additional user support, the app could offer even greater ease of use and accessibility.

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