



Validity, Sensitivity and Reliability of HAPUs E-book App for Preventing Incident of Pressure Ulcer on Patients

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Abstract

Background: Pressure ulcers, or bedsores, are a global healthcare challenge, impacting patient well-being and placing significant economic burdens on healthcare systems. Despite advances in prevention strategies, hospital-acquired pressure injuries (HAPIs) remain prevalent due to aging populations, chronic conditions, and gaps in healthcare practices. **Aims:** This study evaluates the validity, reliability, sensitivity, and specificity of the HAPUs E-book app as a digital tool for educating nurses and preventing pressure ulcers. **Methods:** Using the Content Validity Index (CVI), eight experts (five wound care specialists and three IT experts) assessed the app's content validity. Sensitivity and specificity were calculated from trials involving 30 nurses, while Cronbach's Alpha Coefficient was used to evaluate internal consistency across key components. **Results:** The app achieved a CVI score of 1.00, indicating strong content validity. Sensitivity was 95.83%, and specificity was 83.33%, demonstrating high diagnostic accuracy. Cronbach's Alpha scores ranged from 0.73 to 0.82, confirming strong internal consistency and reliability. **Conclusion:** The HAPUs E-book app is a reliable tool for nursing education and pressure ulcer prevention. Its high sensitivity, specificity, and validated content make it suitable for clinical use and continuous professional development. However, further studies with larger populations are needed to generalize findings and assess long-term outcomes.

Keywords: Pressure ulcers; Content Validity Index; CVI; mHealth; Validity

Introduction

Pressure ulcers, also known as bedsores or decubitus ulcers, are localized injuries to the skin and underlying tissues caused by prolonged pressure, often combined with shear or friction. These injuries typically develop over bony

prominences, such as the sacrum, heels, hips, and coccyx, and are a significant concern in healthcare settings worldwide. Globally, the prevalence of pressure ulcers is estimated to be around 12.8%, making them a critical issue due to their impact on patient health and healthcare systems (Li et al., 2020; Sardo et al., 2023).

Several global trends contribute to the increasing prevalence of pressure ulcers. One of the most prominent factors is the aging population. As life expectancy rises globally, particularly in regions like Asia Pacific, the number of elderly individuals at risk for pressure ulcers is growing. By 2050, it is projected that one in four people in this region will be over 60 years old, many of whom may face mobility challenges that increase their vulnerability to these injuries. Additionally, the prevalence of chronic conditions such as diabetes, cardiovascular diseases, and neurological impairments has also risen worldwide (Jiang et al., 2023). These conditions often lead to reduced mobility or prolonged immobility, further heightening the risk of pressure ulcer development. In the United States alone, approximately 2.5 million patients are treated for pressure ulcers annually. Despite advancements in medical care and prevention strategies, hospital-acquired pressure injuries (HAPIs) remain a persistent issue in healthcare systems globally (Padula & Delarmente, 2019; Siotos et al., 2022).

Wan et al., (2023) mentioned the development of pressure ulcers is influenced by a variety of factors. Immobility is one of the most significant contributors, particularly for patients who are bedridden or confined to wheelchairs. Incontinence and excessive moisture can also weaken the skin's integrity, making it more susceptible to breakdown under pressure. Furthermore, gaps in healthcare practices and prevention protocols have hindered progress in reducing the incidence of pressure ulcers. This stagnation highlights the need for improved prevention measures and consistent adherence to evidence-based practices in healthcare facilities (Biçer et al., 2019).

The impacts of pressure ulcers are far-reaching and extend beyond physical health complications. For patients, these injuries can cause significant pain, discomfort, and emotional distress while also reducing their overall quality of life. Pressure ulcers are associated with longer hospital stays and increased morbidity rates, placing additional burdens on patients and their families. From an economic perspective, the financial costs are substantial. In the United States alone, HAPIs are estimated to cost the healthcare system over \$26.8 billion annually, with each individual case potentially exceeding \$10,000 in treatment expenses. This economic burden places strain on healthcare systems worldwide and underscores the importance of preventive measures (Padula & Delarmente, 2019).

The application of technology, particularly mobile health (mHealth) and digital applications, has emerged as a promising approach to preventing pressure ulcers. mHealth technologies, such as the Tilt Tracker (Trapp et al., 2018) and the mULCER platform (Rodrigues et al., 2013), are designed to enhance patient engagement and adherence to preventive measures. These systems provide real-time monitoring and feedback on patient positioning and pressure relief practices, which are crucial for reducing the risk of ulcer development. For instance, the Tilt Tracker uses a dynamic mobile system to objectively measure pressure relief behaviors and syncs this data with a digital communication platform, allowing healthcare providers to monitor patient compliance and intervene when necessary (Trapp et al., 2018).

Such innovations not only facilitate better management of pressure ulcer risks but also empower patients by providing them with personalized alerts and educational resources tailored to their specific needs. Despite the potential benefits of these technologies, there are important considerations regarding the validity and reliability of their content. Ensuring

that the information provided by mHealth applications is accurate and evidence-based is essential for effective pressure ulcer prevention (Do Khac et al., 2021). Many digital platforms rely on algorithms and data analytics to offer recommendations; therefore, it is crucial that these systems are rigorously tested for reliability in various clinical settings. Validity concerns may arise if the technology does not consider individual patient characteristics or specific risk factors associated with pressure ulcer development. Additionally, user engagement can significantly affect the effectiveness of these applications; if patients do not trust or understand the technology, they may be less likely to use it consistently. Therefore, ongoing evaluation and refinement of mHealth tools are necessary to ensure they meet clinical standards and effectively support both patients and healthcare providers in preventing pressure ulcers (Lau et al., 2022). So that, our study aims to identify the validity, reliability and even the sensitivity and specificity of the HAPUs E-Book app as a new application that will be used by nurses in preventing and managing the pressure ulcer on patients.

Materials and Methods

Design

This study is part of the “ Effectiveness Of Smartphone E-Book Application on the visual Differentiation Ability, CLinical Judgment, and performance Towards Pressure Ulcer Prevention Among Nursing” which aimed to enhance the development and validation of a mobile application, namely HAPUs E-book, through a structured expert judgment methodology. A prospective approach was employed, leveraging the expertise of a panel of specialists to ensure the content's relevance and effectiveness. This technique has several advantages, including improved response rates and minimized bias that can arise from direct interactions among expert panel members by maintaining their anonymity. To facilitate this process, a carefully selected expert panel was assembled, comprising individuals with specialized knowledge in the relevant fields.

The validity assessment in this study was the Content Validity Index (CVI), a well-established method for evaluating the quality of measurement instruments. This approach involves scrutinizing individual measurement items to ensure they align with the intended purpose of the instrument (Almanasreh et al., 2018). The researchers engaged eight experts—five wound care specialists and three information technology experts—to provide their insights on the validity of the developed research instruments. Their collective expertise was instrumental in refining the content and ensuring its applicability in real-world settings.

The primary aim of employing CVI was to gauge the level of agreement among experts regarding the relevance of each item in measuring specific constructs. In this study, expert examiners were provided with research instruments related to workplace environment support within the context of pressure ulcer prevention. Each examiner assigned a four-point rating to each item, categorizing them as (1) irrelevant, (2) somewhat relevant, (3) quite relevant, or (4) highly relevant. The scale for calculating the CVI (S-CVI) was derived from averaging these ratings across items, while the Item-level Content Validity Index (I-CVI) was computed by dividing the number of experts who rated an item as 3 or 4 by the total number of experts. The average I-CVI values were then combined to yield an overall S-CVI/Ave score for the instrument.

Conclusion was made according to Saiful and Yusoff (2019), a CVI value of 1.00 is considered ideal for panels consisting of three to five experts, indicating strong consensus on content validity. This value reflects a high level of expert approval regarding the instrument's content. In this study, all questionnaire items achieved a CVI value of 1.00, confirming their validity as per the criteria established by Polit and Beck (2020).

After we gathered the validity and reliability of HAPUs E-Book, we conducted an investigation of our product sensitivity and specificity which was implemented and evaluated by 30 nurses.

Results

In this study, sensitivity the probability of correctly identifying true cases, was calculated based on the following outcomes: true positives (TP) involved 23 participants, true negatives (TN) included 5 participants, while false negatives (FN) and false positives (FP) each involved one participant (Table 1). The resulting sensitivity was 95.83%, indicating a high likelihood of accurately diagnosing cases, while the specificity was 83.33%, reflecting the system's ability to minimize false positives. These results suggest that the HAPUs E-book application is highly suitable for confirmation testing scenarios where accuracy in detecting outcomes is critical.

Table 1. Frequency of HAPUs E-Book Trial among Nurses (N=30)

Evaluation	Pressure Ulcer (+)	Pressure Ulcer (-)
Test (+)	23	1
Test (-)	1	5

To ensure reliability, the study employed Cronbach's Alpha Coefficient, a widely used statistical measure for assessing internal consistency within learning applications. This method evaluated how well individual items on a test or questionnaire correlate with one another to provide a reliable measurement tool. Cronbach's Alpha values range from 0 to 1, with values above 0.7 generally considered indicative of good reliability. For this study, the Cronbach's Alpha scores for key components—visual differential ability, clinical judgment, and performance in HAPUs prevention measurements—were 0.78, 0.73, and 0.82, respectively. These values demonstrate strong internal consistency across different aspects of the application, confirming its reliability as an educational and diagnostic tool.

The integration of advanced digital tools like the HAPUs E-book application represents a significant step forward in healthcare education and pressure ulcer prevention. By combining evidence-based content with robust validation processes, this application provides a reliable platform for enhancing nurses' knowledge and clinical decision-making skills. Furthermore, its high sensitivity and specificity make it an effective tool for reducing diagnostic errors, while its strong internal consistency ensures that learning outcomes are measured accurately and consistently.

Discussion

This study developed and validated an interactive HAPUs E-book app training program based on the 2014 guidelines for preventing and treating pressure ulcers. The findings demonstrate the app's potential as an effective educational tool for healthcare professionals, particularly nurses, by offering a flexible and interactive learning experience. The intervention group, which utilized the PU E-book app alongside lectures, benefited from the ability to access the material anytime and anywhere, with session durations of 15–20 minutes. This contrasts with the control group, which followed a traditional classroom-based lecture format lasting 60 minutes per week. The integration of digital tools into educational programs reflects a growing trend in healthcare to leverage technology for improving knowledge dissemination and clinical practice.

These findings have significant implications for nursing education and clinical practice. The high sensitivity and specificity rates highlight the app's potential as a reliable tool for diagnosing pressure ulcer risks, while its flexibility and accessibility make it a valuable resource for continuous professional development (Shreffler & Huecker, 2023).

Furthermore, the strong internal consistency demonstrated by Cronbach's Alpha scores reinforces confidence in the app's ability to deliver consistent and accurate educational content

Moreover, the app's flexibility and accessibility make it an invaluable resource for continuous professional development among nursing staff. In an era where ongoing education is essential for maintaining high standards of care, the app provides a convenient platform for nurses to enhance their knowledge and skills related to pressure ulcer prevention (Shreffler & Huecker, 2023). This aligns with current trends emphasizing the need for healthcare professionals to engage in lifelong learning to stay abreast of best practices and emerging evidence in patient care (McKeown et al., 2022).

The strong internal consistency demonstrated by Cronbach's Alpha scores (ranging from 0.73 to 0.82) further reinforces confidence in the app's educational content. High internal consistency indicates that the various components of the app work well together, providing users with coherent and reliable information essential for effective clinical decision-making (Al Mutair et al., 2020). This reliability is crucial in ensuring that nurses can trust the content they are using to inform their practice, thereby enhancing the overall quality of care provided to patients at risk for pressure ulcers. Incorporating validated digital tools like the HAPUs E-book app into nursing curricula and ongoing training initiatives can significantly improve patient outcomes.

Evidence suggests that educational interventions focused on pressure ulcer prevention can lead to lower incidence rates of these injuries in clinical settings. For instance, studies have shown that comprehensive educational programs can effectively reduce HAPU rates by equipping healthcare professionals with the necessary knowledge and skills to implement preventive measures (Gross, 2021).

Furthermore, as healthcare systems increasingly prioritize patient safety and quality improvement, integrating such resources into practice not only supports compliance with evidence-based guidelines but also fosters a culture of proactive care (Yap et al., 2023). By utilizing tools like the HAPUs E-book app, healthcare facilities can enhance their strategies for preventing pressure ulcers, ultimately contributing to better patient outcomes and reduced healthcare costs associated with treating these preventable injuries. In summary, the HAPUs

However, some limitations must be acknowledged. First, while the CVI score reflects expert consensus on content validity, further testing with larger and more diverse populations is needed to generalize these findings across different healthcare settings. Additionally, although sensitivity and specificity analyses provide valuable insights into diagnostic accuracy, future studies should explore long-term outcomes related to patient care and pressure ulcer prevention following app usage.

Despite these promising results, several limitations must be acknowledged. First, while the CVI score reflects expert consensus on content validity, further testing with larger and more diverse populations is needed to generalize these findings across different healthcare settings. The sample size of 30 nurses may limit the statistical power of sensitivity and specificity analyses; thus, larger studies are warranted to validate these results further. Second, this study primarily focused on short-term outcomes related to knowledge acquisition and diagnostic accuracy immediately following training with the HAPUs E-book app. Longitudinal studies are necessary to assess how well knowledge retention translates into clinical practice over time and whether this ultimately leads to improved patient outcomes in pressure ulcer prevention.

Additionally, while participants in both groups received similar content regarding pressure ulcer prevention, variations in learning styles and preferences may influence how effectively each group assimilates information. Future research should explore these differences to tailor educational approaches more effectively. Lastly, reliance on self-reported data from participants regarding their knowledge and motivation may introduce bias into the findings. Objective measures or performance assessments could provide a more robust evaluation of learning outcomes.

Conclusions

In conclusion, this study demonstrates that the HAPUs E-book app is a valid, reliable, and effective tool for enhancing knowledge and clinical skills in pressure ulcer prevention among nurses. By integrating evidence-based content with user-friendly digital technology, this app has the potential to transform traditional educational methods in healthcare settings. Future research should focus on scaling its implementation across diverse populations and evaluating its impact on patient outcomes over time. This study contributes to the growing body of literature supporting digital innovations in healthcare education as a means to improve both professional competencies and patient care quality.

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