

# Application to prevent pressure injury in elderly caregivers

Aplicativo para prevenção de lesão por pressão para cuidadores de idosos  
 Aplicación para prevención de úlcera por presión para cuidadores de personas mayores

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## Abstract

**Objective:** To develop and validate the content of a mobile application prototype on Pressure Injury (PI) Prevention for elderly caregivers.

**Methods:** Methodological study of prototype-type technological production in mobile application. The application development was guided by the Contextualized Instructional Design (CID) model. The content validation stage was carried out by seven teaching nurses of a technical course for elderly caregivers in a federal educational institution with the application of the Suitability Assessment of Materials (SAM) instrument. Data were analyzed using descriptive statistics.

**Results:** The prototype, which was named LPPrev, contains information about the concept, staging, causes of LP, and main affecting sites, in addition to reminders to reposition the elderly in bed; registration of nutritional information, oral hydration, body and intimate hygiene, and guidance on preventive care is also possible. The content evaluation obtained 96.6% of agreement between professors, being considered a material of superior quality.

**Conclusion:** LPPrev is an application prototype properly structured according to the categories evaluated by the SAM, with relevant information for caregivers of bedridden and dependent elderly, contributing to theoretical knowledge and fundamental care in the prevention of injury by pressure, being prepared to move on to the other stages of the DIC model.

## Resumo

**Objetivo:** Desenvolver e validar o conteúdo de um protótipo de aplicativo móvel sobre Prevenção de Lesão por Pressão (LP) para cuidadores de idosos.

**Métodos:** Estudo metodológico de produção tecnológica do tipo protótipo em aplicativo móvel. O desenvolvimento do aplicativo foi guiado pelo modelo de *Design* Instrucional Contextualizado (DIC). A etapa de validação de conteúdo foi realizada com sete enfermeiros docentes de um curso técnico para cuidador de idosos em uma instituição federal de ensino com a aplicação do instrumento *Suitability Assessement of Materials* (SAM). Os dados foram analisados usando a estatística descritiva.

**Resultados:** O protótipo, que foi nomeado LPPrev, contém informações sobre conceito, estadiamento, causas das LP, principais locais de acometimento, além de lembretes para reposicionar o idoso no leito; há também possibilidade de registro de informações nutricionais, hidratação oral, higiene corporal e íntima e disponibilização de orientações sobre cuidados preventivos. A avaliação de conteúdo obteve 96,6% de concordância entre os docentes, sendo considerado um material de qualidade superior.

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**Interest conflicts:** manuscript extracted from the master's dissertation entitled: "*Desenvolvimento e validação de conteúdo de protótipo de aplicativo móvel para prevenção de lesão por pressão em idosos institucionalizados*", which was presented to the Graduate Program in Nursing (Universidade Federal da Paraíba; 2022).

**Conclusão:** O LPPrev é um protótipo de aplicativo adequadamente estruturado segundo as categorias avaliadas pelo SAM, com informações relevantes aos cuidadores de idosos acamados e dependentes, contribuindo para o conhecimento teórico e cuidados fundamentais na prevenção de lesão por pressão, estando preparado para avançar para as demais etapas do modelo de DIC.

## Resumen

**Objetivo:** Elaborar y validar el contenido de un prototipo de aplicación móvil sobre la prevención de úlcera por presión (UP) para cuidadores de personas mayores.

**Métodos:** Estudio metodológico de producción tecnológica de prototipo en aplicación móvil. El desarrollo de la aplicación fue guiado por el modelo de diseño educativo contextualizado (DEC). La etapa de validación de contenido fue realizada por siete enfermeros docentes de un curso técnico para cuidadores de personas mayores de una institución educativa nacional, mediante la aplicación del instrumento *Suitability Assessment of Materials* (SAM). Los datos se analizaron con estadística descriptiva.

**Resultados:** El prototipo, que fue llamado LPPrev, contiene información sobre el concepto, estadificación, causas de la UP, principales lugares de acometimiento, además de recordatorios para reposicionar a la persona mayor en la cama. También tiene la posibilidad de registrar información nutricional, hidratación oral, higiene corporal e íntima y dispone de instrucciones sobre cuidados preventivos. La evaluación de contenido obtuvo un 96,6 % de concordancia entre los docentes, por lo que es considerado un material de calidad superior.

**Conclusión:** El LPPrev es un prototipo de aplicación bien estructurado según las categorías evaluadas por el SAM, con información relevante para los cuidadores de personas mayores encamadas y dependientes. Contribuye para el conocimiento teórico y los cuidados fundamentales para la prevención de úlcera por presión y está preparado para avanzar hacia las siguientes etapas del modelo de DEC.

## Introduction

The aging process associated with common diseases in the elderly sometimes limits their movement. Thus, the risks for the development of Pressure Injury (PI) increase, directly impacting the quality of life, as well as the investment in human resources and inputs for the treatment of elderly people.<sup>(1,2)</sup>

The elderly caregivers are responsible for promoting the autonomy of elderly people, helping them with their physical, mental, and social well-being. Care practices involve encouraging independence and self-care; assistance with body and mouth hygiene, as well as skin hydration; assistance in providing diet and oral hydration; mobility support for those who walk with difficulty and bed mobility for dependent and bedridden elderly; safety promotion for the elderly; and guidance and monitoring of family members in the care of the elderly.<sup>(3)</sup>

Considering the role of elderly caregivers in preventing pressure injuries and the risk of developing injuries in dependent and bedridden elderly people, investments must be continually made in strategies and technologies that favor prevention. Thus, mobile applications are characterized as a technology that can help learning, allowing access to content without restriction of time and space.<sup>(4,5)</sup>

In a careful search carried out in databases, active mobile applications aimed at elderly caregivers focusing on the prevention of PI in bedridden and dependent elderly people were not found. Thus, it

is justified to develop an application incorporating this information as a resource to facilitate access to information on PI prevention for elderly caregivers, being able to become an ally to maintain the integrity of the skin of the elderly, keeping caregivers informed and confident about daily practices in the care of bedridden elderly people or those with limited movement.

Applications whose contents are compatible with the knowledge and attributions of elderly caregivers can become a promising technology to optimize preventive care for pressure injuries in dependent and bedridden elderly people, thus reducing PI rates in elderly people with reduced mobility in the future.<sup>(6,7)</sup>

Thus, this study emerged from the following question: How to develop and validate a mobile application prototype for use by elderly caregivers, capable of providing educational content and guidelines for the practice of preventive care for pressure injury in dependent and bedridden elderly? In this context, the aim of this study was to develop and validate the content of a mobile application prototype on pressure injury prevention for elderly caregivers.

## Methods

This was a methodological research of the technological production type of a mobile applica-

tion of educational character, built based on the Contextualized Instructional Design (DIC) model.<sup>(8)</sup> In this study, the steps of analysis, design, and content validation are described.

### 1<sup>st</sup> step: Analysis and design

At this stage, the main purpose of prototyping, target audience, learning needs for caregivers, and the existence of mobile application on the subject were delimited, in addition to the characteristics and functions necessary to develop the prototype application.

Initially, an integrative review of the literature to verify the possible existence of educational and didactic content to prevent pressure injury was carried out in the databases MEDLINE via PubMed, CINAHL, SCOPUS, Web of Science, and LILACS, including the search for applications on the *Google Play* and *App Store* platforms. The search was carried out in the period March-April 2021, without restriction regarding the year of publication of the studies. The descriptors “Mobile Applications” OR “Mobile Apps” AND “Pressure Ulcer” were used, resulting in 13 publications. No application found was shown to target elderly caregivers.

The available applications that address the PI topic do not provide complete information needed by elderly caregivers to prevent PI, being insufficient to meet the requirements of preventive care. Thus, the educational content based on the prevention and treatment guide for PI from the European Pressure Ulcer Advisory Panel<sup>(9)</sup> was structured to be used in the prototype and matrix of instructional design.

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### 2<sup>nd</sup> step: Content validation

After the design phase of the application prototype, the content was validated by an expert committee in

June 2022. To select the judges, the criteria adapted from Teixeira<sup>(10)</sup> were adopted; they include meeting at least three of the following criteria: clinical-assistance experience with the target audience for at least three years; having studies published in journals and/or events on the subject (elderly people, pressure injuries, and caregivers); to be a specialist (*lato sensu* and/or *stricto sensu*) in the nursing area or topic; and having teaching experience in the area of gerontological nursing.

The literature recommends five to 10 expert judges for the content validation process.<sup>(11)</sup> Thus, the non-probabilistic intentional-type sample was adopted; it was composed of nurse professors of the Technical Course in Care for the Elderly, in a Technical Health School of the Federal Teaching Network in the Northeast Region of Brazil.

The professors were contacted by email through an invitation letter sent to participate in the validation of application content. Eleven nursing professors who agreed to participate in the study were invited. The following documents were then forwarded by email: the free and informed consent form (FICF) for signature; the *link* to access the high-fidelity application prototype from the Figma software (with guidance on how to handle it); screens in PDF format; the questionnaire for professional characterization; and the Suitability Assessment of Materials (SAM) instrument. After 20 days, eight professors returned the completed instruments.

The SAM is an instrument translated and adapted into Brazilian Portuguese,<sup>(12)</sup> which allows assessing the difficulty and convenience of educational materials related to health, obtaining the adequacy or unfeasibility of the material studied at the end. It is composed of 22 items, subdivided into six sub-items: content, writing style, graphic illustration, presentation, motivation, and cultural appropriateness.

To calculate the total score, the score for each item must be added, divided by the maximum SAM score (44 points), and multiplied by 100. The percentage obtained must be interpreted in categories of agreement: inadequate (0-39%), adequate (40-69%), and superior (70-100%) material. Thus, categories evaluated with agreement  $\leq 39\%$  must be reformulated.<sup>(13)</sup>

The collected data were tabulated in spreadsheets (*Microsoft Office Excel*) and analyzed using descriptive statistics (absolute and relative frequencies). The comments and suggestions of the specialist professors are presented in a chart.

The research followed the ethical aspects recommended by the National Health Council (Resolution 466/12). The study was approved by the institutional Ethics Committee (Opinion 5.253.187; Presentation Certificate for Ethical Appreciation: 54208721.8.0000.5188).

## Results

### Characteristics of LPPrev

The application was named LPPrev. This name was preferred due to the meaning of the abbreviations: preventing pressure injuries was the main objective. Thus, “LP” refers to pressure injury, and “Prev” refers to prevention, and this nomenclature is easily understood by the target audience.

The application prototype LPPrev was developed to provide elderly caregivers with the main information about pressure injury, such as concept, causes of development, and care for maintaining intact skin, aiming to prevent PI and identify its presence.

The application has 44 free *mockups* (screens) for navigation and its palette uses mainly white, green, and blue colors; they were chosen to provide delicacy, comfort, and well-being, keeping the elements harmonious, with similar color variations when the highlight is needed.

The initial screens of LPPrev welcome users, with information on the incidence of PI in elderly residents in long-stay institutions, with login options for caregivers registered on the platform and registration for new users.

After registering and logging in to the platform and viewing the concepts and causes of LP, the user-caregiver is directed to the main screen, with access to the application’s menu, offering options for the following: Register Elderly, where caregivers must fill in data (elderly name, weight, height, age, and presence of comorbidities); View Active

Elderly, allowing access to data of elderly people registered in the application (who require care); and Learn More: Pressure Injury (with access to educational content on the subject).

After the caregiver registers the elderly and accesses the information in Active Elderly (by clicking on the available icons), he/she will have access to the Menu with information about Bed Repositioning, Oral Hydration, Nutrition, and Basic and Intimate Hygiene. These options will allow for generating daily reports on places and times of repositioning of the elderly, daily fluid intake, number of baths taken, intimate hygiene, and diaper changes, as well as acceptance of meals by the elderly. The user will be able to activate reminders with a sound alarm at each time of care for the elderly person as established.

In the “Learn More about Pressure Injury” menu, caregivers will have access to educational topics such as: What is pressure injury; Higher risk cases; Stages of pressure injury; Risk locations for injuries, and How to prevent. By clicking on each of these topics, educational and illustrative information will appear, conceptualizing LP and listing the causes of LP development. This allows caregivers to gather knowledge and reflect on the compatibility or not of the conditions of the elderly under their care with the causes of PI, thus identifying (via images) the characteristics of PI; this also makes it possible to differentiate intact skin from LP from other lesions and to describe and point out the main regions of bony prominence with a higher risk of developing LP.

Caregivers will also be able to find guidance on positioning and repositioning, pressure relief, oral nutrition and hydration, hygiene, moisture control, and skin hydration, as well as instructions on what to avoid and what not to do. Figure 1 shows some of the LPPrev screens.

### Content validation

Regarding the profile of the specialist professors who participated in the content validation, their mean age was 46.6 years and 75.0% of them had a doctorate in nursing or related areas. The specialists had publications in journals and/or books on the subject (elderly, caregiver, and pressure injury) and

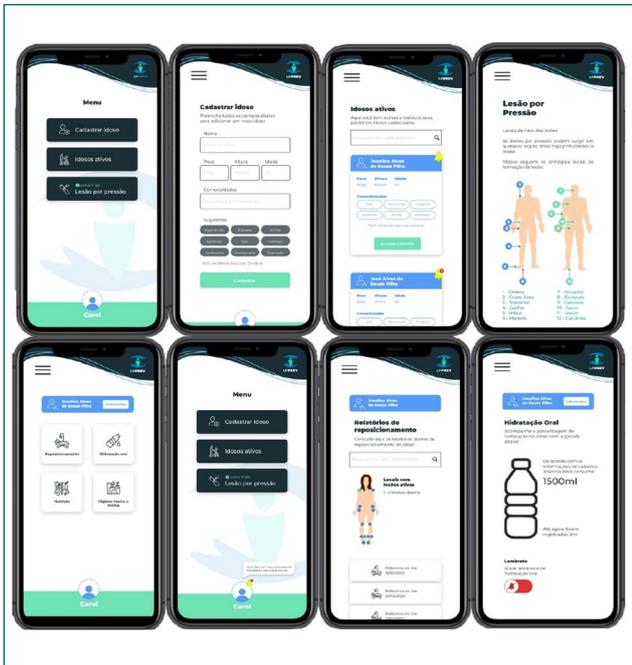


Figure 1. The interface of the LPPrev screens

87.5% of them had clinical experience in caring for elderly people. As for the evaluation of the prepared material, the global score of the SAM was 96.6%, being considered an application prototype of superior material according to the instrument classification (Table 1).

Chart 1 shows a summary of comments and suggestions from specialist nurses and participants in the LPPrev validation process. The suggestions were analyzed and those based on the composition of the application were accepted.

## Discussion

Evidence from the literature describes that the main risk factors for the onset of PI are the following: aging, nutritional status of the elderly, cutaneous and

Table 1. Distribution of expert scores according to the items of *Suitability Assessment of Materials*.

Assessment Items	E1	E2	E3	E4	E5	E6	E7	E8
1. Content								
The objective is evident, which facilitates the understanding of the material.	2	2	2	2	2	2	2	2
In the content, information that influences the prevention of PI is addressed.	2	2	2	2	2	2	2	2
The content is aligned with the objective.	2	2	2	2	2	2	2	2
Content highlights key points for preventing LP.	2	2	2	2	2	2	2	2
2. Language								
The level of text clarity is adequate for readers' comprehension.	2	2	1	1	2	2	2	2
Writing in the active voice is used.	2	2	2	2	2	2	2	2
Vocabulary includes common words.	1	2	2	1	2	2	2	2
The concept of LP comes before new information.	2	2	2	2	2	2	2	2
Learning is facilitated by topics.	2	2	2	2	2	2	2	2
3. Graphic illustrations								
The purpose of the illustration referring to the text is clear.	2	2	2	2	2	2	2	2
The illustrations translate the context of the theme.	1	2	2	2	2	2	2	2
Figures and/or illustrations are relevant.	1	2	2	2	2	2	2	2
Figures and/or illustrations are self-explanatory.	2	2	1	2	2	2	2	2
Illustrations have short captions.	2	2	2	2	2	2	2	2
4. Layout and presentation								
The features of the <i>layout</i> are compatible with the theme.	2	2	2	2	2	2	2	2
The font size and type allow for comfortable reading.	2	2	1	2	1	2	1	1
Subheadings are used for better understanding.	2	2	2	2	2	2	2	2
5. Motivation								
The item uses interaction.	2	2	2	2	2	2	2	2
The guidelines are specific and give examples.	2	2	2	2	2	2	2	2
The application promotes motivation and self-efficacy.	2	2	2	2	2	2	2	2
6. Cultural adequacy								
The material is culturally appropriate to its rationale, language, and audience experience.	2	2	1	2	2	2	2	2
The item features culturally appropriate imagery.	2	2	2	2	2	2	2	2
Sum (Σ)	41	44	40	42	43	44	43	43
SAM Score* by Expert (%)	93,2	100	90,9	95,5	97,7	100	97,7	97,7
Overall SAM Score* (%)	96,6 (Superior application prototype)							

E: Specialist; 2: Adequate; 1: Partially adequate; 0: Inadequate

**Chart 1.** Expert suggestions for the LPPrev application according to the *Suitability Assessment of Materials*.

Application Dimensions	Accepted suggestions	Unaccepted suggestions
Content	E1: Recommend the correct use of skin protectors (barrier cream).	E2: Insert other feeding devices, such as nasogastric tubes, gastrostomy, and jejunostomy.
Language	E1: As for the term "patient", use another term not associated with 'hospital care'. E3: Change the term "patient" to "elderly" or "elderly person". E7: Enlarge the font size in the item "Learn more about LP".	E4: Replace the word "wound drainage" with "body fluid secretion" or specify the fluids (serous, bloody, serosanguinous, mucopurulent, and purulent). E4: Replace the word "Drag" with "move" the elderly person, due to the impact of the word.
Graphic illustrations	E3: Review acronyms describing their meanings, e.g., AVC (stroke). E1: Use images of cushions or pillows to illustrate the positions.	E1: Include images that favor the application user to compare intact and non-intact skin. E7: In the images of the item "Stages of the LP", insert in the caption the names of the regions that show the LP.
Layout and presentation	E1: Review spacing and follow the pattern. E3: Increase font sizes. E5: Adapt the size and color of fonts according to the background color. E7: Increase font sizes. E8: Increase font sizes.	
Motivation		E7: Guide the caregiver in front of the already established pressure injury, with a field to describe the evolution of the PI.
Cultural adequacy		E1: Reserve space to address myths that can interfere with care for people with PI.

capillary fragilities, fecal and urinary incontinence, restlessness, decreased levels of consciousness and mobility, humidity, friction, shearing, and infections.<sup>(14,15)</sup>

The LPPrev mobile application prototype has the potential to be incorporated into the daily lives of caregivers of elderly people, contributing to individualized, safe, and quality practices, strengthening knowledge, helping to clarify doubts, and increasing care through suggestions and guidelines based on current scientific evidence.

Although assessing and intervening to prevent PI is not the competence of elderly caregivers, they must understand the concept of PI, the main risk factors (intrinsic and extrinsic), the risk regions that favor the emergence of lesions, differentiating lesions from the types of involved tissues, thus guiding the preventive care personalized, always paying attention to the comprehensiveness and needs of individuals, guided by good practices and health safety.<sup>(6,16)</sup>

The mobile application "Without Pressure" agrees with the educational topics and functionalities addressed in this investigation, being aimed at preventing PI in adult patients. It targets health professionals and features similar resources for risk, staging, staging imaging, and preventive care;<sup>(17)</sup> however, it does not include other features available in LPPrev such as water intake control and sound alarms.

The functionality of following and recording the amount of fluids ingested by the elderly es-

tablishes the minimum amount of water intake, considering 30 ml of water per kg of body weight. Thus, the application calculates the amount per ml needed by each elderly person.<sup>(18)</sup> The total volume of water needed per day is weighted for seniors who have pre-existing co-morbidities; the medical and nursing guidelines on hydration for the elderly addressed to the caregiver are observed activating the water restriction, being able to change the volume when necessary and recommended.

We emphasize that reminder-type sound alarms have been used to perform tasks, aiming to avoid forgetting. For the self-management of arterial hypertension, an application that uses alarms was developed to remind users to take daily medications, being pre-programmed for medications and times.<sup>(19)</sup>

The teaching nurses assessed the content using the Suitability Assessment of Materials (SAM) instrument; they also evaluated the ease of understanding of the text and graphic illustrations, the presentation, motivation, and cultural adaptation, qualifying the educational technology with the superior level (global agreement score: 96.6%).

Educational methodological studies have used the SAM to assess the adequacy of technologies. The instrument was applied in a survey that aimed to validate a mobile application to promote foot care for people with diabetes and obtained a 90.0% agreement.<sup>(20)</sup> Another investigation, which validated the content of the application "NASF in Network" (with the partici-

pation of seven specialists), obtained a percentage of agreement of 83.5%.<sup>(21)</sup> According to the variables evaluated by the SAM, LPPrev presented superior results, evidencing the quality of the elaborated content.

None of the evaluated items was considered inadequate; however, comments and suggestions were provided by the committee of experts to refine the technology; they were later evaluated by the authors who accepted some of them.

As for the suggestion of inserting nasoenteric and nasogastric tubes, gastrostomy, and jejunostomy as options for feeding routes, the indication was not accepted because the handling of these devices is the responsibility of the nursing team; this care is instituted to administer diets to elderly people unable to take food orally (due to reduced level of consciousness, dysphagia, low acceptance, etc.), with potential risks of broncho-aspiration.<sup>(22)</sup>

One expert recommended replacing the term “drag” with “move”; this suggestion was not followed because the term “drag” is used in the item risk factors for the development of PI, being a practice mistakenly applied in some scenarios. Thus, maintaining the term is necessary to reinforce that this practice is not recommended, as the change of position should ensure that there is no friction of the skin on the bed, which increases friction and the risk of epidermal rupture.<sup>(3,23)</sup>

Replacing the word “drainage of wounds” with “secretion of body fluids” or “specifying which fluids are” was also suggested. This suggestion was not accepted for two reasons: first, considering that “wound drainage” can be more easily understood by caregivers (he/she will directly look in injuries for the presence of fluids, not body fluids coming from other areas or body orifices such as mouth and anus); second, because characterizing the liquids or types of exudates is not the responsibility of elderly caregivers (their responsibility is to identify the presence of this sign and seek a competent health professional to provide care). In long-stay institutions for the elderly, caregivers must communicate the fact to the nurses, who will characterize the drainage, classify the injury, and carry out the necessary and possible therapeutic interventions.<sup>(3,24)</sup>

As for the layout and presentation of the application, four specialists judged the size and type of the font as partially adequate for comfortable reading, suggesting increasing the size of fonts and adapting the background on some screens. The font size is automatically adjusted according to the mobile device. There is no consensus on the ideal font size for applications, as the content view varies according to the screen dimensions and the smartphone model. However, these suggestions were accepted and the zoom option for reading will be incorporated into the device’s programming, thus providing greater quality to the application in this regard.

This study presented some limitations in the set of DIC stages, such as development, implementation, and evaluation of the prototype, which were not performed due to the high financial cost. Future research may carry out the other DIC stages that were not included in this study; thus, the mobile application will be released free of charge to the target audience and the scientific community on the main virtual platforms. Although experts considered the technology to be superior, validating the prototype appearance with elderly caregivers for possible understanding adjustments was not possible. A further study will be carried out to refine the content and evaluate the usability of the application through the attributes of effectiveness, efficiency, and satisfaction of the end users.

We hope that this research can foster interest in the development of new educational technologies aimed at elderly caregivers to strengthen their theoretical and practical knowledge. In long-stay institutions for the elderly, nursing teams and caregivers will be able to incorporate technology into clinical practice, as a support tool to clarify doubts and strengthen prevention and education activities in health related to LP.

## Conclusion

The LPPrev application prototype presents evidence of superior content validity. It has a self-explanatory graphical interface, reminder-type alarms of times

for change of position and repositioning, information on acceptance of the offered diet, water intake control, and filling in of information on potential PI risks, intending to contribute to improving individualized and holistic assistance.

## Collaborations

Gomes ACMS, Sousa MM, Silva MA, Matos SDO e Oliveira SHS contributed to the study design, data analysis and interpretation, manuscript writing, relevant critical review of the intellectual content, and approval of the final version to be published.

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