

## Mobile application "Prevention of dependency-related skin injuries"

Aplicación móvil "Prevención de lesiones cutáneas relacionadas con la dependencia"

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## ABSTRACT

**Background:** the prevention of dependency-related skin injuries constitutes a frequent challenge that requires accessible educational tools such as mobile applications.

**Objective:** to design an educational mobile application for the preparation of caregivers in the prevention of dependency-related skin injuries.

**Methods:** a development research was carried out from March 2023 to October 2024 at the Chiqui Gómez Lubian University Polyclinic in Villa Clara. The process included three stages: determination of criteria for the design, assembly of the application, and expert validation. Theoretical methods were used: analysis-synthesis, inductive-deductive, historical-logical and modelling; empirical methods: documentary analysis, caregiver interviews and focus group.

**Results:** the application included educational content, a risk calculator, an image gallery, a posture change clock and bibliographic materials. It is compatible with Android 14 or higher and requires no additional storage resources. Expert assessment showed consensus on clarity, relevance and high acceptance of the navigation elements.

**Conclusions:** an innovative application was designed for the preparation of caregivers in the prevention of dependency-related skin injuries, which promotes a preventive, person-centred health model.

**MeSH:** caregivers; e-accessibility; knowledge management; information technology; education, medical

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## RESUMEN

**Fundamento:** la prevención de lesiones cutáneas relacionadas con la dependencia constituye un reto frecuente que requiere herramientas educativas accesibles como las aplicaciones móviles.

**Objetivo:** diseñar una aplicación móvil educativa para la preparación de los agentes del cuidado en la prevención de lesiones cutáneas relacionadas con la dependencia.

**Métodos:** se realizó una investigación de desarrollo en el periodo marzo 2023-octubre 2024, en el Policlínico Universitario Chiqui Gómez-Lubian, en Villa Clara. El proceso incluyó tres etapas: determinación de criterios para el diseño, montaje de la aplicación y validación

por expertos. Se utilizaron métodos teóricos: análisis-síntesis, inductivo-deductivo, histórico-lógico y modelación; empíricos: análisis documental, entrevista a cuidadores y el grupo focal.

**Resultados:** en la aplicación se incluyeron contenidos educativos, calculadora de riesgo, galería de imágenes, reloj de cambios posturales y materiales bibliográficos. Es compatible con Android 14 o superior y no requiere recursos adicionales de almacenamiento. La valoración por expertos mostró consenso en la claridad, pertinencia y alta aceptación en los elementos de navegación.

**Conclusiones:** se diseñó una aplicación innovadora para la preparación de los agentes del cuidado en la prevención de lesiones cutáneas relacionadas con la dependencia, la cual promueve un modelo de salud preventivo y centrado en las personas.

**DeCS:** cuidadores; e-accesibilidad; gestión del conocimiento; tecnología de la información; educación médica

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## INTRODUCTION

Population ageing and the increase in chronicity place family caregivers as fundamental pillars of the sustainability of health systems globally.<sup>(1)</sup> These caregivers, who often assume responsibility without specific training, face complex care demands, among which is the prevention of complications in people with dependency.<sup>(2)</sup> In this context, the integration of supportive technological solutions stands as a necessary strategy to empower them and provide them with tools that improve the quality of care provided and, by extension, the quality of life of the person in their charge.<sup>(3)</sup>

Mobile health applications (mHealth), and particularly Android Package Kit (APK) applications, emerge as highly valuable resources for health education and self-care support. Their accessibility, low cost and social penetration make them ideal platforms to reach a population of caregivers who often experience isolation and overload. An APK designed with scientific rigour can offer personalised guides, reminders and immediate action protocols, transforming the mobile device into a constant ally in daily care work, even in environments with intermittent connectivity.<sup>(4)</sup>

The importance of APKs transcends the individual sphere and constitutes a crucial element in the modernization of health systems. The strategic implementation of information and communication technologies (ICTs) is an indicator of efficiency and quality, allowing the decentralization of care and fostering co-responsibility in health management. Their systematic use not only optimizes resources but also establishes a two-way channel that can strengthen the link between the informal caregiver and health professionals.<sup>(5)</sup>

Among the most pressing challenges faced by caregivers are dependency-related skin injuries (DRSI): pressure ulcers, incontinence-associated dermatitis, and friction and shear injuries. Their development has a profound impact on the morbidity and mortality of ill people and represents a significant economic and emotional burden. Although their prevention is feasible through evidence-based protocols, the correct application of these by caregivers requires a continuous and accessible educational process.<sup>(6)</sup>

In the reviewed literature there is no precedent for a mobile application aimed at family caregivers for the prevention of DRSI, so its development and validation is presented as an initiative of great scientific and social relevance, by helping to correct training gaps, supporting the work of the caregiver and contributing to a proactive, preventive and person-centred health model.

Given this reality, the authors declare the objective of the research: to design an educational mobile application that promotes the preparation of caregivers in the prevention of dependency-related skin injuries.

## METHODS

A development research (design and validation of an educational mobile application) was carried out between March 2023 and October 2024, in the area of Basic Work Group No. 3 of the Chiqui Gómez-Lubian University Polyclinic in Santa Clara, Villa Clara. The population consisted of 80 caregivers and eight nursing professionals. An intentional sample of 20 caregivers who agreed to participate in the research was selected. In both cases, participants completed the informed consent form.

Different methods and techniques were used in the development of the research:

Theoretical level:

- Historical-logical: for the study of the literature on the use of ICTs in the preparation of caregivers. Also, to analyse the background of the problem and the relevance of the topic.
- Analytical-synthetic: in the interpretation of bibliographic resources during the process of creating the mobile application.
- Inductive-deductive: allowed the understanding of the phenomenon under study.
- Modelling: allowed the study of the object being modelled (mobile application) as a system, its composition, structure and functional relationships. It was used in the design stage.

Empirical level:

- Documentary analysis: in the review and study of digital materials, textbook contents and websites related to the prevention of dependency-related skin injuries.
- In-depth interviews: for the purpose of exploring with caregivers the feasibility of a mobile application for their preparation, as well as its possible contents.
- Focus group: with professionals, to ascertain the feasibility of a mobile application for the preparation of caregivers, and its possible topics.

Three stages were taken into account:

Stage I. Determination of criteria for the design of the proposal based on documentary review of the scientific literature on the prevention of dependency-related skin injuries, the criteria issued by the focus group and the in-depth interviews.

Qualitative content analysis and methodological triangulation were performed to define and organise the topics to be included in the mobile application. To this end, the researchers carried out an exhaustive literature review, collected updated and varied material, and took into account the categories that emerged from the analysis.

Stage II. Assembly of the application: all the information on the chosen topics was digitised for the development of the software; the computer tools to be used were also selected. The mobile application was created using Android Studio (Koala | 2024.1.1) as the development environment and Kotlin as the main programming language. The MVVM (Model – View – ViewModel) architecture recommended by Google was used together with Jetpack components (Lifecycle 2.8.6, Navigation 2.7.7, ViewModel, LiveData and ViewBinding). For local persistence of previous calculations and content bookmarks, the Room 2.6.1 library with Kotlin extensions (room-ktx) was implemented. The interface follows Material Design 3 guidelines (Material You, version 1.12.0), to guarantee accessibility and full support for dark mode.

Stage III. Expert validation: allowed recommendations for improving the final product to be taken into account. For this purpose, the strategy for collecting validity evidence based on content by Barraza Macías<sup>(7)</sup> was used. For selection, 20 candidates were identified according to the following criteria:

- Be a health professional with demonstrated experience in the design of educational software
- Hold a scientific degree and have the teaching category of assistant professor or full professor

The expert competence coefficient ( $k$ ) was calculated and had to be greater than 0.80 to form part of the panel. It was constituted by five nursing graduates and nine physicians, total nine; five foreigners and four Cubans; all hold the scientific degree of Doctor of Science in different areas of knowledge and are professionals with demonstrated experience. In addition, they have the required teaching categories, and an average of 30 years of professional experience.

In the assessment of the software, two variables were analysed by the experts: content validity and navigation elements. In both cases, three aspects had to be considered: clarity, relevance and correspondence.

Each aspect was measured in the two variables individually using a Likert-type scale in which Barraza Macías<sup>(7)</sup> proposes four measurement categories for each aspect: does not belong (NP) with a value of zero, probably does not belong (PNP) with a value of one, probably does belong (PSP) with a value of two and does belong (SP) with a value of three. In addition, he recommends that aspects that achieve scores below 1.5 be eliminated, while for items that exceed this value the average should be calculated and the result interpreted using the following scale:

- Between 1.6 and 2 points, the aspect is interpreted as having weak validity
- Between 2.1 and 2.6, the item shows acceptable validity
- Above 2.6, the item is interpreted as having strong validity

Consensus is considered to exist when the three aspects in both variables achieve a score equal to or greater than 2.6.

The research took into account strict compliance with the ethical principles promulgated by the World Medical Association through the Declaration of Helsinki.<sup>(8)</sup>

## RESULTS AND DISCUSSION

From the content analysis of the data from the three empirical methods used in the first stage, categories emerged summarised in Table 1, according to the instrument applied and key findings provided.

**Table 1.** Summary of the results of the empirical methods used in the first stage

Methodological source	Categories	Key findings
Documentary review	Caregiver education and empowerment	Need for planned educational interventions
	Structured and individualized education	Improves knowledge and injury prevention
	Use of ICT in training	Mobile applications, clinical scenarios and online resources are effective
	Emotional closeness	Important for success in training and prevention
Focus group	Prior training	Essential training, especially for inexperienced caregivers
	Educational materials	Need for detailed guides, images, risk calculator and mobile app.
	Professional assistance	Accompaniment and follow-up visits are necessary
In- depth interviews	Prior experience	Accessible app, useful as a guide and complement to professional guidance
	Educational resources	Interest in types of injuries, risk calculation, images, posture changes, and support documents
	Professional guidance	Need for frequent supervision and systematic guidance from nursing staff

Source: empirical methods

Once the data were triangulated, the findings converged into three integrated dimensions that constitute the need areas of the caregivers; these guided the design of the mobile application. The integrated dimensions resulting from the methodological triangulation are shown in Table 2.

**Table 2.** Integrated dimensions resulting from the methodological triangulation

<b>Integrated dimension</b>	<b>Application contents</b>
Structured training	<ul style="list-style-type: none"> <li>• Educational content on DRSI</li> <li>• Prevention steps</li> <li>• Norton Scale and its interpretation</li> </ul>
Practical tools	<ul style="list-style-type: none"> <li>• Risk calculator</li> <li>• Image gallery of injuries</li> <li>• Posture change clock</li> <li>• Bibliographic materials in PDF</li> </ul>
Accompaniment and usability	<ul style="list-style-type: none"> <li>• Intuitive interface</li> <li>• Video tutorial</li> <li>• Compatibility with Android</li> </ul>

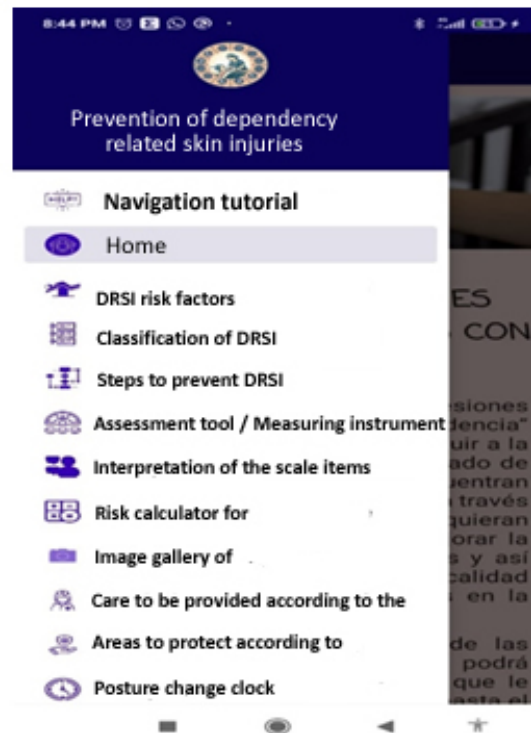
Source: methodological triangulation

The application "Prevention of dependency-related skin injuries" was designed with the aim of providing information, guides and tools for the preparation of caregivers in the prevention of this type of injury in primary health care. It is managed to be intuitive and accessible, offering educational content and useful resources to caregivers and other users. It was developed in Android Studio, the official integrated development environment for Android applications. Kotlin, a modern and official language for the development of this type of application since 2017, was used for this purpose.

The application is compatible with devices running Android 14 or higher, which ensures that it takes advantage of the latest Android features such as security improvements, performance optimisation and compatibility with new user interfaces. It has no additional

storage or processing requirements, which means it can be used by a wide range of mobile phones with that operating system. The generated data are in eXtensible Markup Language (XML), Joint Photographic Experts Group (JPEG) and Portable Document Format (PDF), making the information 117 megabytes in size.

It contains a start interface that informs its purpose and shows its identifier; another interface that accesses the contents of the mobile application, as shown in Figure 1. It also includes a video tutorial that allows knowledge users to learn how to navigate through each of the contents. Among the topics, it includes information on risk factors to avoid, as well as the classification of DRSI. It also provides the steps to prevent injuries, a description of the Norton Scale and the interpretation of the items of this instrument. To facilitate calculation for caregivers, it provides a risk calculator that allows rapid and accurate determination.



**Fig. 1.** Contents

Source: own elaboration

One of the main virtues of the software is its image gallery, visible in Figure 2, through which users can identify the types of injuries. Another feature of undoubted value is the interface that allows users to consult all the care that must be provided to dependent people according to the calculated risk level, as well as the areas of the skin that should be protected in each position.



**Fig. 2.** Image gallery  
Source: own elaboration

The application provides a posture change clock that guides the frequency with which position changes should be made. Finally, it has a bibliography interface that includes two updated materials on the subject in PDF format, published by the National Group for Advice on Pressure Ulcers and Chronic Wounds, which allow users to delve deeper into the content; and finally, another screen with the professional information of its authors.

The assessment carried out by the experts on both the content of the application and the navigation elements with respect to clarity, relevance and correspondence is shown in Table

3. 100% agreed that the content is clear, relevant and has correspondence for the intended purpose. In relation to the navigation elements, 100% rated them as clear and 88.89% agreed that they have relevance and correspondence. According to the content assessment methodology proposed by Barraza Macías,(7) an average score of 2.97 was achieved, which is interpreted as a strong overall content validity.

**Tabla 3.** Valoración de la aplicación móvil según criterios de expertos

Variables	Aspects	PSP	%	SP	%	Total	%
Content validity	Clarity	0	0,0	9	100,0	9	100,0
	Relevance	0	0,0	9	100,0	9	100,0
	Correspondence	0	0,0	9	100,0	9	100,0
Navigation elements	Clarity	0	0,0	9	100,0	9	100,0
	Relevance	1	11,11	8	88,89	9	100,0
	Correspondence	1	11,11	8	88,89	9	100,0

Source: expert criteria

From the position of Iglesias Posadilla *et al.*,<sup>(9)</sup> there are several advantages attributed to the use of applications in the health field. Among these, the following may be highlighted: rapid access to information, portability, security, ease of use –provided by everyday familiarity– access to networks, and data storage. They state that there are currently multiple health-related applications, some aimed at sick people or caregivers, and others at professionals. In this sense, the authors are of the criterion that the existence of various applications encourages users to employ these technologies, which are intended to optimise health in various aspects. In particular, they have been used in primary disease prevention, health education aimed at the self-care process and guided therapies, as well as in the rehabilitation of different health events such as acute myocardial infarction.

In Cuba, an example of this is the application HTACUBA, which began its development in 2018. Its foundation was the need to digitize the Cuban Guide for that disease, put forward

by the National Commission on Arterial Hypertension. For this reason, its creation facilitated unlimited access for people to the contents of the guide.<sup>(10)</sup>

Another example is the Virtual Screener application, which allows information to be obtained about people's health status as a complement to the COVID-19 response process. Likewise, Covid-19-InfoCu was created at the request of the Cuban Ministry of Public Health to quickly and truthfully inform and guide the population about the COVID-19 pandemic caused by SARS-CoV-2.<sup>(11)</sup>

There is evidence of the development of the interactive application NeuroPark between January and May 2018 at the Bayamo Faculty of Medical Sciences. It was created to facilitate the learning of Parkinson's disease by medical science students.<sup>(12)</sup>

More recently, the development process of the software FarmacoApp was published at the Villa Clara University of Medical Sciences, conceived to improve the teaching of General Pharmacology to students.<sup>(5)</sup> The subject it enhances brings together the contents and skills that are basic for the correct application of Clinical Pharmacology, and therefore helps the student to critically analyze information about medications and put it into practice.

In the international context, the use of technology and artificial intelligence in Nursing sciences is gaining increasing prominence. This is reaffirmed by Espín Arguello *et al.*,<sup>(13)</sup> who carry out an analysis of the current state of the use of applications in the care area. They thus describe the existence of a significant number of applications aimed at professionals, patients and caregivers as support tools for such human labour.

In the authors' opinion, it is a challenge for discipline professionals to safeguard one of the inherent characteristics of nursing care: humanized and personalized treatment supported by the advent and accelerated technological development. Therefore, a harmonious link must exist between technology and professional practice to achieve the comprehensive well-being of people, families and communities.

Currently, research addressing the design process or impact evaluation of programmes aimed at caregivers of people with different health conditions, in various settings, is of great value. These educational programmes aimed at informal caregivers in which the use of ICTs is put into practice have a positive impact on improving emotional well-being and the caregiver role.

Among these experiences is that presented by Gallardo Solarte *et al.*,<sup>(14)</sup> who, due to the increase in people with chronic diseases worldwide, together with the emergence of the family caregiver figure, designed an educational proposal focused on the competencies that caregivers should have, which improved in 90.0% of caregivers, especially among those who were part of the study group and received the intervention through the programme.

In Argentina, Grabois<sup>(15)</sup> developed an educational programme for self-care and support for people with diabetes and their caregivers. In this way, she sought to promote self-care, reduce complications and improve the survival of these people in the community. According to the author, the design of health educational strategies must be based on knowledge and understanding of the particularities of the people to whom it will be directed, which includes their culture, beliefs, age, gender identity, economic situation, affective support environment and support networks; as well as the physical, social and virtual environment in which they live.

In relation to this point, the authors believe that the fact of including knowledge users from the beginning of the study, exploring their perceptions and taking their criteria into account about the designed mobile application is evidence that the above elements were considered. Furthermore, involving caregivers in the design process increases motivation for the learning that is generated as part of their preparation, and this begins in practice from the very start of the application's creation.

The application offers practical resources that promote a humanized, person-centred care model. Consequently, this research contributes to modifying the health care paradigm by incorporating ICTs as training support, offering a replicable model for future educational applications in nursing and public health.

#### Scientific contribution

The scientific contribution lies in the creation and validation of an educational mobile application that integrates scientific evidence, pedagogical methodologies and technological tools to strengthen the preparation of caregivers in the prevention of DRSI. Furthermore, the research demonstrates the feasibility of using modern development environments such as Android Studio and the Kotlin language to generate accessible, intuitive and compatible software with current devices, thereby guaranteeing its sustainability and social reach.

## CONCLUSIONS

A mobile application was designed for the preparation of caregivers in the prevention of DRSI, which helps to empower family caregivers and optimise the quality of care. The study provides an innovative model that integrates technology, scientific evidence and humanisation of care, with potential impact in primary care and other healthcare settings. The expert assessment confirmed strong content validity and acceptability of navigation: guarantees of its relevance as a training resource.

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### **Declaration of interests**

The authors declare no conflict of interest.

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