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Building m-health technology to promote breastfeeding

Construção de tecnologia m-health para promoção do aleitamento materno

Creación de tecnología de salud móvil para promover la lactancia materna

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Abstract

Objective: to develop an m-health technology to promote breastfeeding in nursing mothers. **Methods:** methodological study, carried out from February 2020 to July 2021. Technological development application, following Pressman's prototyping model. The content was based on the precepts of Meaningful Learning, elaborated through a situational diagnosis and an integrative review, which guided the compilation of information and guidelines. It has a Computer Program Registration Certificate from the National Institute of Industrial Property (Process No. BR512021002438-9). **Results:** the application is entitled "Amamente" (Breastfeeding), and consists of the visual identity of the nursing mother, the welcome screen, and the "We want to meet you" screen. This is followed by eleven interactive interfaces for ouaccessing guidance and information such as breastfeeding; milk production; my breasts; signs of correct positioning; signs of correct latch-on; milk extraction; breast problems; signs of effective breastfeeding; when not to breastfeed; mom's space and references. **Conclusion:** the technology was built successfully and its final version brought together national and international scientific recommendations. "Amamente" can be used as a resource with potential reach and favorable to the process of health education and future interventions for mothers during breastfeeding.

Descriptors: Breastfeeding; Mobile Applications; Health Education; Educational Tecnology.

Whats is already known on this?
The m-health technological innovations used to support breastfeeding can be an essential educational resource for nursing mothers, but there are gaps in development based on scientific evidence.

What this study adds?
It highlights the stages of building m-health technology with innovative, low-cost educational potential, scientifically-based guidance, and easy access to breastfeeding for mothers.

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Resumo

Objetivo: *desenvolver uma tecnologia m-health para a promoção do aleitamento materno em nutrizes.* ***Métodos:*** *estudo metodológico, realizado de fevereiro de 2020 a julho de 2021. Aplicativo de desenvolvimento tecnológico, seguindo o modelo de prototipação de Pressman. O conteúdo foi embasado pelos preceitos da Aprendizagem Significativa, elaborados por meio de um diagnóstico situacional e uma revisão integrativa, os quais nortearam a compilação das informações e as orientações. Apresenta o Certificado de Registro de Programa de Computador do Instituto Nacional da propriedade Industrial (Processo Nº BR512021002438-9).* ***Resultados:*** *o aplicativo intitula-se "Amamente", e é composto pela nutriz na identidade visual, tela de boas-vindas, e queremos conhecer vocês. Logo em seguida, onze interfaces interativas de acesso às orientações e informações como: aleitamento materno; produção de leite; minhas mamas; sinais de posicionamento correto; sinais de pega correta; extração de leite; problemas mamários; sinais de amamentação eficaz; quando não amamentar; espaço da mamãe e referências.* ***Conclusão:*** *a tecnologia foi construída com êxito e sua versão final reuniu as recomendações científicas nacionais e internacionais. O "Amamente" constitui a possibilidade de ser utilizado como um recurso com potencial alcance e favorável ao processo de educação em saúde e futuras intervenções para as nutrizes durante a amamentação.*

Descritores: *Aleitamento Materno; Aplicativos Móveis; Educação em Saúde; Tecnologia Educacional.*

Resumén

Objetivo: *desarrollar una tecnología m-health para promover la lactancia materna en madres lactantes.* ***Métodos:*** *estudio metodológico, realizado de febrero de 2020 a julio de 2021. Desarrollo tecnológico aplicado, siguiendo el modelo de prototipado de Pressman. El contenido se basó en los preceptos del Aprendizaje Significativo, elaborados a través de un diagnóstico situacional y una revisión integradora, que guiaron la recopilación de informaciones y orientaciones. Presenta el Certificado de Registro de Programa de Computación del Instituto Nacional de la Propiedad Industrial (Trámite N° BR512021002438-9).* ***Resultados:*** *la aplicación se llama "Amamente", y está compuesta por la identidad visual de la madre lactante, una pantalla de bienvenida y queremos conocerte, y luego 11 interfaces interactivas para acceder a orientaciones e informaciones como: lactancia materna; producción de leche; mis pechos; señales de posicionamiento correcto; signos de agarre correcto; extracción de leche; problemas en los senos; signos de lactancia materna eficaz; cuando no amamantar ; el espacio y los referentes de mamá.* ***Conclusión:*** *la tecnología fue construida exitosamente y su versión final cumplió con las recomendaciones científicas nacionales e internacionales. La lactancia materna constituye la posibilidad de ser utilizada como un recurso con potencial alcance y favorable al proceso de educación en salud y con futuras intervenciones para las madres lactantes durante la lactancia.*

Descriptores*: Lactancia Materna; Aplicaciones Móviles; Educación em Salud; Tecnología Educacional.*

INTRODUCTION

Breastfeeding (BF) is considered to be the ultimate reference for infant feeding and plays a key role in promoting maternal and child health, given that breastfeeding is a natural, economical, and effective method and its numerous benefits have been extensively described in the literature.[1-3]

The World Health Organization (WHO) and the Ministry of Health (MH) draw attention to the rates of Exclusive Breastfeeding (EBF) in children up to the sixth month of life, where these rates remain below the recommended level, especially in Brazil, reaching 45.7%, with the northeast region performing this practice less frequently, reaching only 38%.[4,5]

The use of technological innovations in the health field has seen significant growth as an economic didactic and technological strategy, with instant access and direct and rapid communication of information, and has proved to be effective in building knowledge, critical awareness, and health promotion.[6-8]

M-health applications (APPs) have been used in various contexts, international studies have shown their growing use in the last decade as a facilitating tool for health promotion and a new educational-care resource[9]. Mobile apps, for example, can be effective in promoting breastfeeding and reducing early weaning rates, directly reflecting on the success of breastfeeding.[10,11]

It is believed that mobile applications can contribute to increasing the practice of breastfeeding by disseminating information, provided that their construction includes user participation, based on their experiences and suggestions, as well as listening to professionals with expertise in the area and based on scientific evidence, resulting in an increase in maternal ability to breastfeed through mothers' access to information about breastfeeding, strengthening their ability to deal with their child's needs.[12]

In this context, it is believed that the use of this m-health technology can contribute to the adoption of care empowerment, disseminate knowledge about breastfeeding, increase adherence to the practice, increase breastfeeding rates, and increase continued breastfeeding since this technology has great potential for providing useful information and guidance that is appropriate to the needs of mothers.

This study aims to develop an m-health technology to promote breastfeeding among nursing mothers.

METHODS

This is a methodological study, developed from February 2020 to June 2021, at the Center for Research Applied to Data Analysis (RADA) of the Federal University of Piauí/ Senador Helvídio Nunes de Barros Campus (UFPI/CSHNB), as part of the dissertation entitled "Construction and validation of m-health technology for the promotion of breastfeeding".

The development of the application followed the stages of the prototyping model proposed by Pressman[13]: 1. Situational diagnosis, bibliographic survey, and definition of content; 2. Interface design; 3. Definition of software requirements; 4. Elaboration of the application's conceptual model (planning); 5. Software development (Modeling/Prototyping) and 6. Implementation and testing.

Initially, the study carried out a situational diagnosis of the causes related to low breastfeeding rates, early weaning, and technologies aimed at the health education process for mothers during the breastfeeding process. This was followed by an integrative literature review in the Scientific Electronic Library Online (SciELO), US National Library of Medicine (MEDLINE), Latin American and Caribbean Health Sciences Literature (LILACS), and the Virtual Library of Scientific Information (CAPES/MEC Journals Portal). The general descriptors and their combinations in Portuguese and English were used: "Amamentação"/"Breastfeeding"/"Tecnologia educacional"/"Educational technology"/"Educação em saúde"/"Health Education", associated with each other using the Boolean operators AND and OR. Articles available in full in Portuguese and English, published in the last ten years, which were in line with the guiding question, were selected by reading the title and abstract, and then reading the work in full.

In order to develop the m-health technology, a logical content structure plan was followed, including the key aspects for contextualizing and taking care of the causes of early weaning, based on the manuals of the Ministry of Health[4,14] and the guidelines of the Brazilian Society of Pediatrics.[15,16] The proposal to design an app with carefully selected content and guidelines on breastfeeding will positively influence breastfeeding among the target audience (nursing mothers).

Then, in the second stage, the interface design of the textual and non-textual elements (illustrations/videos) of the app's content was carried out by a trained technical professional in partnership with the development team, in order to format and layout the screens with a visual design and attractive graphic interface, easy-to-understand language and in line with the socio-cultural context of the target audience, in accordance with Moreira, Nóbrega, and Silva's guidelines for educational health material.[17-19] The Adobe® Illustrator® software was used to create the illustrations and videos in vector format, which were sent to the development team for supervision and, after approval, were sent to the application programmer.

As for the third stage, a survey of mobile apps was carried out in February 2020 on the Google Play Store digital app distribution service, using the following keywords: BF and breastfeeding, available free of charge. In this sense, an app was built aimed at developing skills in nursing mothers and providing information and guidance, highlighting the main difficulties during the breastfeeding practice.

The next stage consisted of a meeting via the Google Meet platform between the research team and the developer to draw up the app's conceptual model, as well as defining pertinent issues such as functionalities, control mechanics, app style, and interaction of m-health technology with nursing mothers, following the precepts of Ausubel's Significant Learning, through meaningful educational material, seeking to align its benefits with the teaching-learning of nursing mothers, in obtaining information, ease of use, motivational resources and autonomy.[17,20,21]

The fifth stage involved the development of the application, based on the dynamic software engineering prototype of the Incremental Model, as it enables simultaneous and continuous construction, with the sixth stage of executing and adjusting the interface of textual and non-textual elements (layout and design) in accordance with the selection of content, as well as making it possible to add new functionalities, which resulted in the final version of the technology.[22]

The project to which this study is linked was approved by the Research Ethics Committee of the Federal University of Piauí, under opinion No. 3.764.351, ensuring compliance with the scientific recommendations of Resolution No. 466/2012 of the National Health Council (NHC).

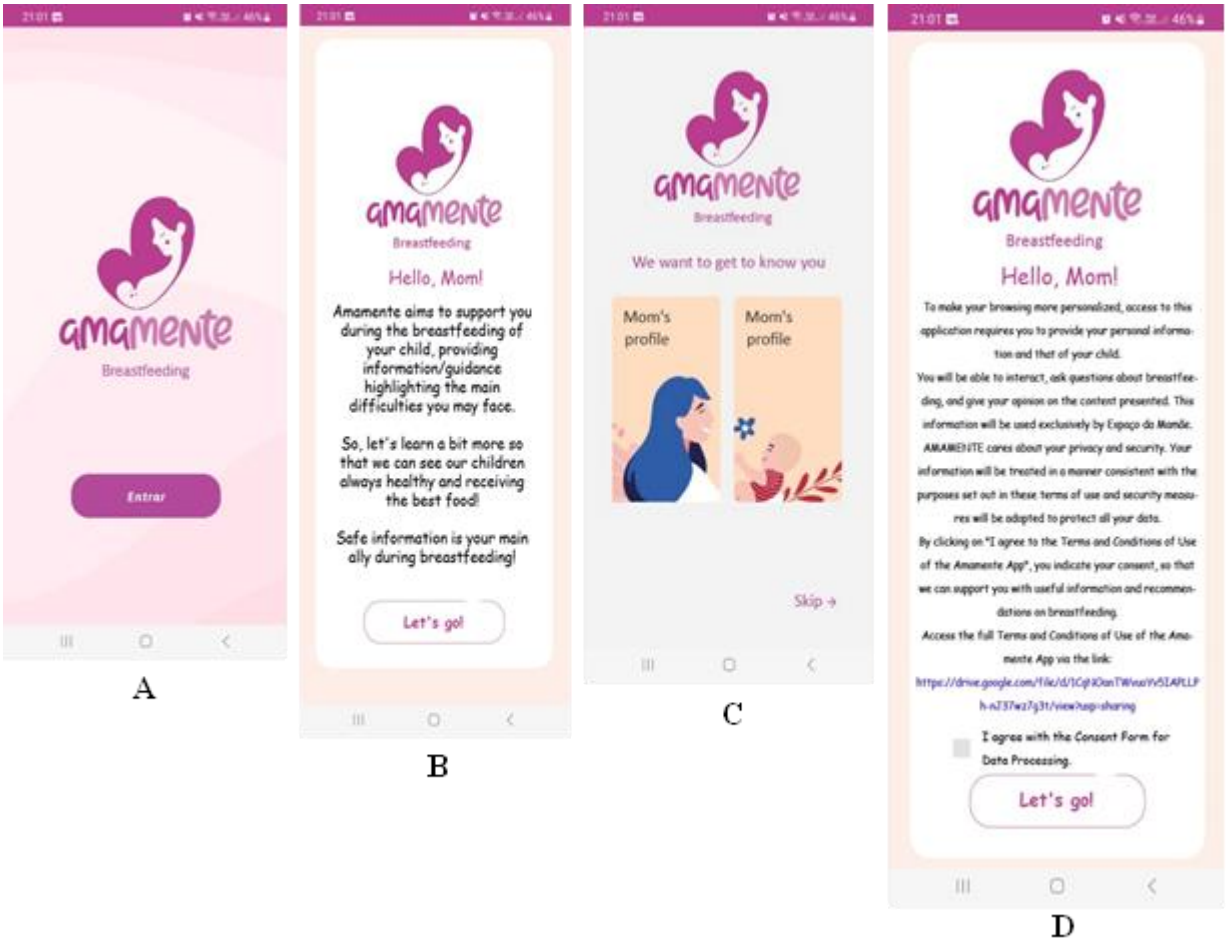
The "Amamente" application is registered with the National Institute of Industrial Property (INPI) under process No. BR512021002438-9.[23]

RESULTS

The "Amamente" app was developed using the Incremental Model methodology, JavaScript, Framework and React programming languages, Visual Studio Code, and the PostgreSQL database management system version 13.2, targeting the Android platform, which is the most popular operating system and has held a prominent position in the Brazilian market since 2015, accounting for more than 90% of smartphones, which makes "Amamente" more available to a significant portion of the Brazilian population.[24]

The home screen consists of the visual identity (Figure 1A). By clicking on "log in", the user is directed to a welcome screen where they are presented with the possibility of accessing an additional tool for the breastfeeding health education process, including a brief description of the app (Figure 1B).

Figure 1. Initial screens of the "Amamente" app. (A) Visual identity; (B) Brief description; (C) We want to get to know you; (D) General Personal Data Protection Law. Teresina (PI), Brazil, 2021.



Source: Elaborated by the authors (2021).

In the central part of the "We want to get to know you" screen (Figure 1C), there are two icons that direct the user to register (personal profile, obstetric, and breastfeeding information) and their child (personal profile, growth, and daily breastfeeding record). The data relating to the mother's registration will be stored in a database that can only be accessed by the main researcher, whose data will be protected and guaranteed security, confidentiality, and privacy, in compliance with the General Law on the Protection of Personal Data (GLPPD) (Figure 1D), the screen has a field at the bottom for the mother to click on to give her consent to the use of her data for possible future research, followed by the access link to read the full term.

In order to meet the "Personal Information" requirements of the "Mother's Profile", an option was added to identify the user by adding a photo and also to create a personal data register with open-ended answers: name, date of birth, city, address, cell phone and e-mail contact, individual registration number,

number of days of maternity leave and sensitive personal data with radio buttons: blood type (A, B, O, and AB), Rh factor (positive/negative), race or ethnicity (do not inform/white/brown/black/yellow/indigenous), marital status (married/unmarried/stable union/other), works outside the home (yes/no) and level of education (Incomplete/complete elementary school/incomplete high school/complete college education/post-graduation/illiterate).

Obstetric information consisted of the following information with radio buttons: type of pregnancy (single/twins), pregnancy planning (yes/no), risk during pregnancy (low risk/high risk), history of abortion (yes/no), type of delivery (cesarean section/vaginal).

Finally, information related to breastfeeding was requested using radio buttons: what is your experience with breastfeeding (excellent/good/moderate/had difficulties/no previous experience), type of nipple (normal/flat/inverted), pain during breastfeeding (yes/no), level of pain (unbearable/intense/moderate/weak/no pain) and the presence of any of the main breast problems during the breastfeeding process (nipple cracks; mastitis; breast engorgement and delayed latch).

The following screens were developed for the child's personal data: gender (radio buttons - boy/girl), date of birth (in the open field), premature baby (yes/no), number of weeks (in the open field, in weeks), weight (in the open field - in kg), length at birth (in the open field - in centimeters), skin-to-skin contact in the first hour of life (yes/no); growth (current weight in the open field - in kg/current length in the open field - in centimeters/automatically calculated BMI) and daily breastfeeding record: breastfeeding time (with clock indicating start and end), breast offered (left/right/both), offer to your child (breast milk/formula/cow/goat/water/tea/juice/porridge), and the offer of liquid and/or pasty food (in the open field).

Next, the "Icon Initialization" screen was divided into eleven interactive interfaces, totaling 89 screens and 11 educational videos, based on the primary aspects of contextualization and care during breastfeeding, where all the content present in the technology was prepared by the development team, namely: 1. Breastfeeding; 2. Milk production; 3. My breasts; 4. Signs of Correct Positioning (SCP); 5. Signs of Correct Latch-On (SCLO); 6. Milk extraction; 7. Breast problems; 8. Signs of effective breastfeeding; 9. When not to breastfeed; 10. Mother's space and 11. References (Figure 2). Each interface of the app is independent, which allows the user to access as many or as few icons as she wishes, without having to follow an order.

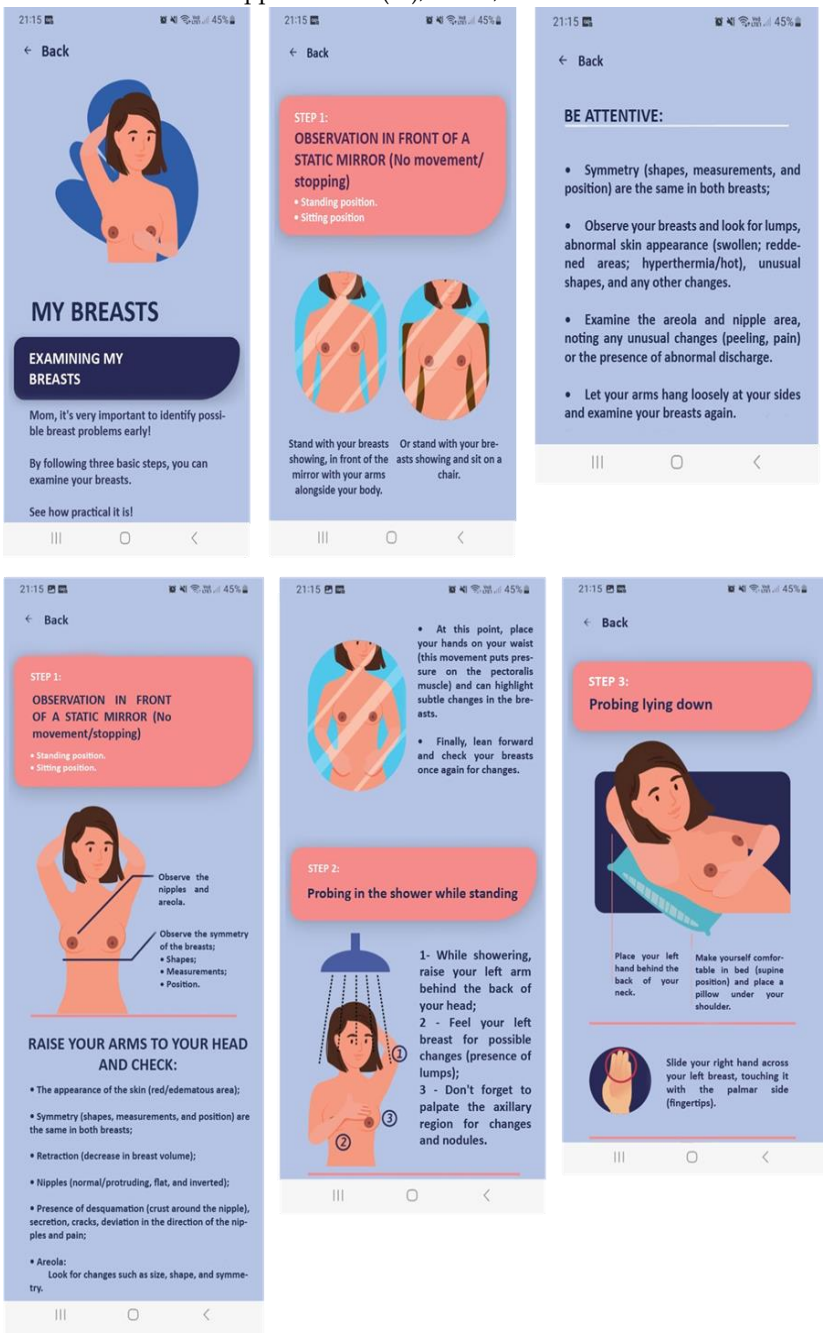
Figure 2. "Amamente" app icon initialization screen. Teresina (PI), Brazil, 2021.

Source: Elaborated by the authors (2021).

The "BF" icon presents the concepts of EBF, Predominant BF, Complementary BF, and Mixed or Partial BF; the recommended time for EBF and starting complementary feeding; and information on the benefits of breastfeeding for the health of the mother and child. The "Milk production" icon covers the process of milk production, the factors that favor and hinder milk production, translactation, composition, characteristics, and stages of breast milk.

Concerning the "My breasts" icon, there is a step-by-step explanation of how to examine the breasts with the help of a booklet with guidance on the following situations: observation in front of the mirror (static/standing/sitting) and (dynamic/standing/sitting), palpation in the shower while standing, palpation while lying down, changes that can be detected during breast examination, types of nipples, and breast care (Figure 3).

Figure 3. Excerpt from the booklet on breast care, inserted into the "My breasts" icon of the "Amamente" app. Teresina (PI), Brazil, 2021.



Source: Elaborated by the authors (2021).

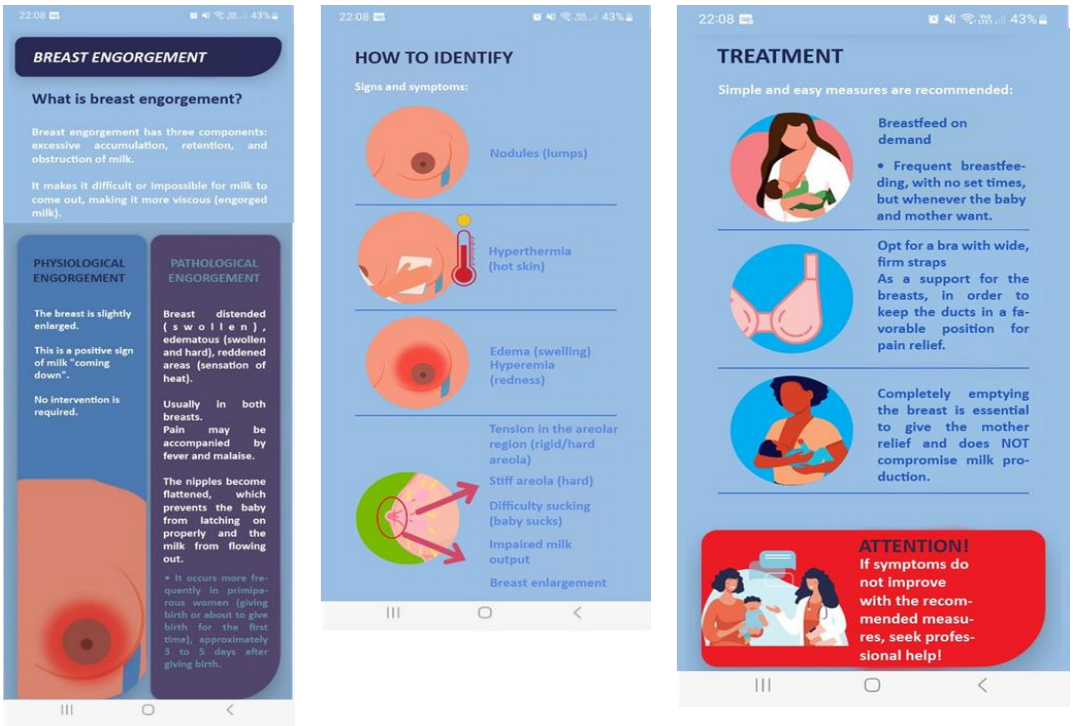
With regard to the "SCP" and "SCLO" icons, animations demonstrate the correct technique, so that you can learn the key points of the mother's four main positions during breastfeeding: breastfeeding lying

down, sitting, standing, and in the horse position, and the essential instructions for correctly positioning the baby on the breast (Figure 4).

Figure 4. Screen with the selection "Signs of correct latch-on" (excerpt from the animation) from the "Amamente" app. Teresina (PI), Brazil, 2021.

Source: Elaborated by the authors (2021).

Figure 5. Excerpt from the booklet on breast engorgement inserted into the "Breast Problems" icon of the "Amamente" app. Teresina (PI), Brazil, 2021.



Source: Elaborated by the authors (2021).

For better clarification, the "Milk extraction" icon shows an animation containing the necessary materials and demonstrating how to carry out the procedure correctly, as well as adding knowledge built up during extraction or manual and pump milking, how to store the milked milk, guidelines with the extracted milk and the cupping technique (Figure 4).

The "Signs of effective breastfeeding" icon explains the signs of an effective breastfeeding process for the mother and her baby with screens containing illustrations and a brief explanation (Figure 4).

The "When not to breastfeed" icon describes the maternal conditions that require temporary interruption of breastfeeding, as well as guidelines for such situations, and includes a link to the Breastfeeding and Use of Medicines and Other Substances Manual offered by the Ministry of Health and E-lactancia (Figure 4).

The topics covered in the "Breast Problems" icon (Figure 5) include the pathophysiology of the most common complications during breastfeeding, namely: nipple fissures or cracks, breast engorgement, mastitis, and delayed latch-on, as well as the signs and symptoms in a simple way, so that the nursing mother can understand through an educational booklet, containing the causes, how to identify, treatment and prevention. A video was also added on how to make a breastfeeding doughnut.

The "Mother's Area" icon is designed for interaction between the nursing mother and a team made up of a nursing professional, a nutritionist, and a pediatrician, trained in the area of breastfeeding, to clarify doubts and questions. User and professional interaction takes place through the application itself, available every day of the week, 24 hours a day in a personalized way, with a response time of less than 24 hours, as well as a means of exposing the nursing mother's opinion and behavior in the face of the information provided by the application. The "References" icon shows the main bibliographies in the area.

DISCUSSION

Some evidence indicates the relevance of developing m-health technologies to promote breastfeeding in nursing mothers. This may be based on the identification that these technologies are scarce in the main online stores. The aim was not just to build another app on breastfeeding, but to develop an innovative virtual teaching-learning environment, aligned with the empowerment of nursing mothers through the provision of scientifically-based guidance, self-care, and the close communication of health care, contributing to the prevalence of breastfeeding.[25,26]

The Ausuberian Theory used as a reference for the conceptual model allowed the application to provide sequenced and flexible navigation of the 11 interfaces of the key aspects of breastfeeding, using an interactive content methodology, resulting in positive evidence of the significant learning process of self-care, knowledge, and support for the mother.[27]

The aim was to provide "Amamente" with screens that are clear and objective, with coherent information on breastfeeding and simple vocabulary, followed by illustrations, educational booklets, and instructional videos associated with the topic, to avoid ambiguity and facilitate learning, in line with existing literature.[28,29]

In order to ensure greater proximity to the topic, the presentation of example situations that can be associated with the interruption of breastfeeding[30], as well as the definition, cause, identification, treatment, and prevention of nipple fissure, breast engorgement, mastitis, and delayed lactation, offered in the application through the "Breast Problems" icon, are essential for assimilating the content, improving the performance of the nursing mother in the process of breastfeeding, favoring the stimulation of critical thinking combined with the use of m-health technologies in the context of health education.[31]

The use of instructional videos in the "SCP", "SCLO" and "Milk extraction" icons stimulates a new way of communicating with the user, enabling them to act correctly in similar situations experienced in their daily lives. In this context of m-health innovations to support integration with health care, the development of a technological resource describing SCP and SCLO techniques increases accessibility to knowledge/education and provides innovative ways of education, as well as inclusion in various sectors of society by integrating health care.[32-34]

Through the use of the "Moom Mãe" app, developed in Thailand, a survey of 21 women showed an increase in the rate of mothers exclusively breastfeeding and a delay in early weaning.[35] This result is in line with the development of apps designed to promote and improve breastfeeding practices.

From this perspective, official bodies such as the Ministry of Health and the WHO encourage the use of m-health technologies aimed at breastfeeding, as they have the potential to facilitate immediate access to information and can be used as an educational resource for mothers during the practice of breastfeeding.[1]

The study has already been validated by expert judges and evaluated by the target audience. The data relating to this validation process is available in Santos (2021) and Veloso (2023) in the Digital Library of Theses and Dissertations (DLTD/UFPI) and in the Digital Library of Monographs DLM/CSHNB.[36,37]

The study's limitation is the lack of accessibility of m-health technology for the visually impaired, due to the interactive interface design (illustrations/instructional videos). However, a hypothesis for

solving this gap is the incorporation of low-cost assistive technology resources so that visually impaired or low-vision mothers can have access to the app's guidance, thereby increasing their skills during breastfeeding. The team responsible for building the app is committed to extending the compatibility of "Amamente" to the Apple Inc. mobile operating system (IOS). Despite these limitations, there was no negative interference in the development of the app.

It is believed that making the "Amamente" app available as a digital distribution service will serve as a tool with potential reach and favorable to health education, giving nursing mothers greater access to scientifically-based information and guidance, and awakening reflections on the positive aspects of breastfeeding, helping with the main doubts in a safe way 24 hours a day, organized, objective and free to access, constituting a strategy to support nursing mothers and promote BF.

CONCLUSION

Amamente" was developed based on national and international recommendations, from the selection of the topics covered, the organization of screens, and instructional resources for the dissemination of guidance and information, such as instructional videos, educational booklets and illustrations, which can minimize the main doubts and the performance and adoption of behavior by nursing mothers in the face of the most common problems during breastfeeding that are statistically associated with early weaning.

It is hoped that making "Amamente" available as a digital distribution service will serve as an additional low-cost tool, with potential reach and favorable to the health education of nursing mothers during breastfeeding.

CONTRIBUITIONS

Contributed to the conception or design of the study/research: Santos JRFM, Lima MA, Machado ALG, Oliveira EAR, Brito AA, Veloso ML, Lima LHO. Contributed to data collection: Santos JRFM, Lima MA, Machado ALG, Oliveira EAR, Brito AA, Veloso ML, Lima LHO. Contributed to the analysis and/or interpretation of data: Santos JRFM, Lima MA, Machado ALG, Oliveira EAR, Brito AA, Veloso ML, Lima LHO. Contributed to article writing or critical review: Santos JRFM, Lima MA, Machado ALG, Oliveira EAR, Brito AA, Veloso ML, Lima LHO. Final approval of the version to be published: Santos JRFM, Lima MA, Machado ALG, Oliveira EAR, Brito AA, Veloso ML, Lima LHO.

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