Development of a mobile application for prenatal care and content validation

Desenvolvimento de aplicativo móvel para o acompanhamento pré-natal e validação de conteúdo

Desarrollo de aplicación móvil para el seguimiento de la atención prenatal y validación de contenido

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Abstract

Objective: To develop a mobile application for pregnant women in prenatal care and validate its content.

Methods: This is a methodological and technological study with a quantitative approach, carried out in three stages: integrative literature review, content validation, and application construction. The review was carried out in bibliographic databases; then, a guide instrument was elaborated covering subjects about prenatal care, childbirth and the puerperium, which underwent an initial validation through a focus group. For the application construction, the following phases were followed: analysis, design, development, implementation and expert assessment. The application construction and content validation were carried out by 21 experts, being 14 obstetric nurses and 7 Information and Communication Technology professionals. Content Validity Index (CVI) was used, considering as an agreement rate values above 80%, inter-rater agreement and Mann-Whitney non-parametric test to verify Delphi 1 and 2 phases.

Results: The application has 111 screens about prenatal care, childbirth, puerperium and breastfeeding, the pregnant woman's virtual notebook, an alarm clock as a reminder of appointments and the contact us menu. After two rounds Delphi technique rounds, agreement was reached between the experts, with an average Content Validity Index of 0.89.

Conclusion: The application obtained an adequate general CVI among experts, showing that the information covered and the system's technical part are reliable, being validated in terms of content. This presents itself as a potential instrument for health promotion with regard to care in the pregnancy-puerperal period.

Resumo

Objetivo: Desenvolver aplicativo móvel para gestantes em acompanhamento pré-natal e validar o conteúdo.

Métodos: Estudo metodológico, tecnológico de abordagem quantitativa realizado em três etapas: revisão integrativa de literatura, validação de conteúdo e construção do aplicativo. A revisão foi realizada em Bases de Dados Bibliográficas; em seguida, um instrumento guia foi elaborado abarcando assuntos sobre pré-natal, parto e puerpério, o qual passou por uma validação inicial, por meio de um grupo focal. Para a construção do aplicativo seguiram-se as fases: análise, design, desenvolvimento, implementação e avaliação de especialistas. A construção do aplicativo e validação do conteúdo foi realizada por 21 especialistas, sendo 14 enfermeiros obstetras e 7 profissionais da área de tecnologia da informação e comunicação. Utilizou-se o Índice de Validade de Conteúdo (IVC), considerando como taxa de concordância valores acima de 80%, Concordância interavaliadores e teste não paramétrico de Mann-Whitney para verificação da fase Delphi 1 e 2.

Resultados: O aplicativo possui 111 telas sobre o pré-natal, parto, puerpério e aleitamento materno, caderneta virtual da gestante, despertador como lembrete de consultas e o menu fale conosco. Após duas rodadas da técnica Delphi, obteve-se concordância entre os especialistas, com índice de validade de conteúdo médio de 0,89.

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Conflicts of interest: nothing to declare.

Conclusão: O aplicativo obteve IVC geral adequado entre os especialistas, evidenciando que as informações abordadas e a parte técnica do sistema são confiáveis, sendo validado quanto ao conteúdo. Este apresenta-se como uma potencial ferramenta para promoção da saúde, no que concerne ao cuidado no período gravídico-puerperal.

Resumen

Objetivo: Desarrollar aplicación móvil para gestantes para el seguimiento de la atención prenatal y validar el contenido.

Métodos: Estudio metodológico, tecnológico de enfoque cuantitativo realizado en tres etapas: revisión integradora de literatura, validación de contenido y elaboración de la aplicación. La revisión fue realizada en bases de datos bibliográficas. Luego, se elaboró un instrumento guía sobre temas relacionados con control prenatal, parto y puerperio, que pasó por una validación inicial, por medio de un grupo focal. Para elaborar la aplicación, se siguieron las siguientes fases: análisis, diseño, desarrollo, implementación y evaluación de especialistas. La elaboración de la aplicación y la validación del contenido fueron realizadas por 21 especialistas, de los cuales 14 eran enfermeros obstetras y siete profesionales del área de tecnologías de la información y la comunicación. Se utilizó el Índice de Validez de Contenido (IVC), considerando como índice de concordancia valores superiores a 80 %, concordancia interevaluadores y prueba no paramétrica de Mann-Whitney para verificación de la fase Delphi 1 y 2.

Resultados: La aplicación posee 111 pantallas sobre control prenatal, parto, puerperio y lactancia materna, libreta virtual de gestante, alarma como recordatorio de consultas y el menú "contáctenos". Luego de dos rondas del método Delphi, se obtuvo concordancia entre los especialistas, con un índice de validez de contenido promedio de 0,89.

Conclusión: La aplicación obtuvo un IVC general adecuado entre los especialistas, lo que deja en evidencia que la información abordada y la parte técnica del sistema son confiables y, de esta forma, el contenido es validado. Se presenta como una herramienta potencial para la promoción de la salud, en lo que respecta al cuidado durante el embarazo y el puerperio.

Introduction

Information and Communication Technologies (ICTs) are a set of technological and computational resources dedicated to information storage, processing and communication, presenting itself as a strong ally to the health sector, especially when it aims to promote health for the population. Its potential, when applied to patients' health, is of critical and strategic importance as it expands the concept of the care environment - a mobile space for interactions interconnecting contexts, subjects and knowledge, in which to care and educate, together, gain prominence and relevance.[1,2]

ICTs are already part of the daily lives of many patients and have the potential to positively impact health promotion through guidelines for the prevention and treatment of diseases and conditions as well as maintaining healthy lifestyle habits. Furthermore, they can promote a closer relationship with professionals and improve users' understanding of their health status, in addition to sharpening their interest in taking care of their own quality of life.[3]

Mobile health technologies, mobile health, are defined as medicine or public health practiced through mobile devices, such as cell phones, patient monitoring devices, personal digital assistants and other wireless devices.[2] Mobile health was recognized by the World Health Organization (WHO) in 2011 as a potential strategy for health practices, favoring the incorporation of this artifact frequently.[3]

Thus, we highlight mobile technologies, such as cell phones, tablets, smartphones, among others, and with them the use of mobile applications (App). All of these alternatives constituted by technologies are important to promote health in different areas or health programs such as prenatal care.

Prenatal care has as main objective to ensure the good development of pregnancy through care, education and guidance, contributing to healthy childbirth and birth. However, the existence of failures in prenatal care, such as barriers to access, late onset and incomplete performance of the recommended procedures, makes it difficult to identify and treat the main complications in the pregnancy cycle - hypertension, hemorrhages, and infections -, affecting the quality and effectiveness of prenatal care. [4,5]

There are also several obstacles to failure to perform prenatal care, highlighting the social inequalities that persist in the country, with less access by indigenous and black women, less education and residents in northern and northeastern Brazil. The lack of link and articulation between services that provide prenatal care and childbirth is another problem identified, resulting in pregnant women's pilgrimage in the care network. [5]

Such problems favor the high rates of maternal mortality, complications at childbirth and the birth of premature children, resulting from lack of diagnosis and treatment of gestational complications.[6] In this context, nurses, as health professionals, can collaborate in prenatal care by developing actions to promote health and prevent complications during pregnancy and childbirth through the use of innovative health technologies.[4]

The mobile apps available for pregnant women, found so far, are aimed only at controlling hypertension, diabetes and weight, prevention of premature birth and urinary tract infection, and reduction of smoking and alcohol consumption.[6-12]

Thus, there was a need to build an App containing information about prenatal care, childbirth, the puerperium and breastfeeding, as well as providing pregnant women's with virtual handbook, alarm for prenatal follow-up appointments and a contact us menu, in order to clarify doubts. Given the above, this study aimed to develop a mobile application for pregnant women undergoing prenatal care and validate its content.

Methods

The study was approved by the Institutional Review Board of *Universidade Federal do Rio Grande do Norte* (UFRN), under Opinion 2,356,769. This is a methodological, technological study with a quantitative approach, carried out from January to December 2018. It consisted of three stages: integrative literature review; application construction; application content validation by nurse-midwives and the usability and applicability of the technological instrument by ICT professionals, who acted as specialists.

Initially, an integrative literature review was carried out to select the content to be made available in the application, based on the following guiding question: what recommendations should be provided to women during prenatal care about pregnancy, childbirth and the puerperium? Thus, content was searched in the Latin American and Caribbean Literature in Health Sciences, Nursing Databases, Scientific Electronic Library Online, Science Direct, Cumulative Index to Nursing and Allied Health Literature, Cochrane, Web of Science, Scopus and Medical Literature Analysis and Retrieval System Online (Medline) databases. The Health Sciences Descriptors (DeCS) and Medical Subject Heading (MeSH) were used, namely: "Prenatal Care", "Pregnancy", "Women's Health", "Nursing", "Childbirth", "Postpartum Period", "Prenatal Care", "Pregnancy", "Women's Health" and "Nursing", "Parturition", "Postpartum Period". These were crossed by means of the Boolean operator AND, from the following 3 X 3 crossings: "*Cuidado Pré-Natal*" AND "*Gravidez*" AND "*Saúde da Mulher*"; "*Cuidado Pré-Natal*" AND "*Gravidez*" AND "*Enfermagem*"; "*Gravidez*" AND "*Saúde da Mulher*" AND "*Enfermagem*"; "*Gravidez*" AND "*Parto*" AND "*Período Pós-Parto*"; "*Gravidez*" AND "*Parto*" AND "*Cuidado Pré-Natal*"; "*Gravidez*" AND "*Parto*" AND "*Saúde da Mulher*"; "*Gravidez*" AND "*Parto*" AND "*Enfermagem*"; "Prenatal Care" AND "Pregnancy" AND "Women's Health"; "Prenatal Care" AND "Pregnancy" AND "Nursing"; "Pregnancy" AND "Women's Health" AND "Nursing"; "Pregnancy" AND "Parturition" AND "Postpartum Period"; "Pregnancy" AND "Parturition" AND "Prenatal Care"; "Pregnancy" AND "Parturition" AND "Women's Health"; "Pregnancy" AND "Parturition" AND "Nursing".

Studies that addressed recommendations on prenatal care, childbirth and the puerperium were included. Articles available in languages other than English, Portuguese and Spanish were excluded. It should be noted that gray literature was used as a complement, including government documents and expert societies documents, such as assistance manuals and protocols.

After reading the articles and materials selected in the integrative literature review, a guide instrument was developed covering subjects related to prenatal care, childbirth and the puerperium. This instrument consisted of a script with content extracted from a literature review carried out in the initial stage. This went through an initial validation process, regarding content, through a focus group composed of eight university professors

from a federal and state educational institution, who were nurse-midwives. The type of validation was by agreement. In this phase, content validation was important to more accurately select the fundamental contents that should compose the *Gestação Saudável* application. This step was based only on content definition.

The application construction was based on the Contextualized Instructional Design (CID) model, which recommends analysis, design, development, implementation and expert assessment.[13]

The analysis step consists of understanding the educational problem and devising a related solution. This involved the survey of needs, the characterization of the target audience, the definition of objectives, the collection of the bibliographic reference, the analysis of the technological infrastructure and the creation of a flowchart.[13] To determine the needs assessment, a field survey was carried out in order to identify the main doubts and what information was important to be received by pregnant women during the pregnancy-puerperal period. Thus, the focus group (FG) technique, composed of 24 pregnant women who underwent prenatal care at a Family Health Unit in a municipality in northeastern Brazil, was adopted. There were two meetings, with an average duration of one hour, each composed of 12 pregnant women. The emerged speech was recorded, transcribed and analyzed.

As the framework adopted in the study involves characterizing the target audience[13], the SisPreNata/DATASUS database was consulted. This access occurred in 2018, in the municipality where FG was performed, allowing the identification of pregnant women's age, education, number of children, beginning of prenatal care, number of consultations performed, examinations performed, vaccination and puerperal consultation.

Then, the objective of constructing a mobile application was outlined and the bibliographic reference was collected through an integrative review, previously described. In an analysis of the technological infrastructure, the application interface structure, content sequence and media selection were defined. Thus, content was transformed into didactic material, compatible with the application format, in an attractive way for the target audience, using images. Finally, a flowchart was developed to guide the instrument construction and, afterwards, transform the idea into a product (Figure 1).

Figure 1 represents the flowchart of the *Gestação Saudável* application with its menus and illustrates the most frequent question in each trimester of pregnancy, identified in a field research carried out in the need assessment stage, with the same focus group described previously.

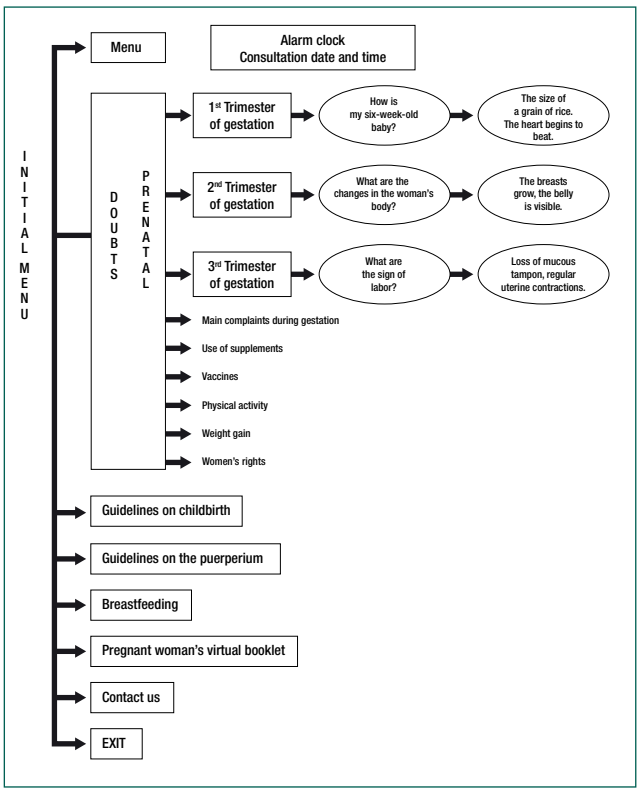

Figure 1. Graphical representation of the screens of *Gestação Saudável*

The design used in the application construction involved planning and producing didactic content, media selection, and interface design (layout).[13] The development comprised selecting the application instruments, defining the navigation structure and planning the configuration of environments. The implementation included the use of technological resources, the configuration of instruments and installation on the mobile device. The assessment presented an analysis of experts in relation to contents, didactic resources and interface of the environment.[13]

The prototype was developed by a technology professional using the Android Studio instrument, the Java programming language, supported by the following frameworks: 1) Java Server Faces-JSF, a Java framework for the Web; 2) Spring, a framework for the management of the application modules and dependencies; 3) Hibernate, a framework for object-relational mapping in the database.[13]

As for language used in the interface, the guidelines - simplicity, clarity and objectivity - were followed, making content accessible to pregnant women. The system developed was named *Gestação Saudável*. With the construction of the application completed, validation of applicability and usability began. For this, the Delphi technique was used, with an agreement level of 80%.[13,14]

Regarding the number of judges, in the present study, the suggestion of a minimum of six experts for the validation of technologies and instruments was adopted.[15] However, it is emphasized that there is no agreement in international literature on the minimum number of judges, but rather the agreement on the importance of clinical experience in the formation of an expertise profile as well as the need for balance between experience and solid academic background.[16]

Emails were sent to 48 nurse-midwives, with a return of 26 in the first round and 14 in the second, and 43 invitations for technology professionals, with 28 participants in the first round and 7 in the second. The assessment forms were returned within the stipulated period of 30 days. Expert selection took place through the Lattes platform (*Plataforma Lattes*) and contact via invitation letter through email. The experts who participated in the study signed the Informed Consent Form (ICF).

The inclusion criteria for expert nurses were: being an expert in nursing-midwifery; holding a master's or doctorate degree in nursing; professor at a higher education institution in nursing-midwifery or women's health; with previous performance in Family Health Strategy or maternity; authorship of works published in prenatal care journals. For ICT professionals/experts, the following criteria were used: graduated in science and technology; ICT experts; master's or doctorate degree holders in science and technology; authorship of works published in journals on mobile health applications; professor at a higher education institution. It was adopted as an exclusion criterion, for both, not to update the curriculum in the last six months.

For data collection, two separate forms were created in the Google Drive® storage service. A form was sent to the group of nurses who carried out content assessment, and the other form was sent to the group of ICT experts who assessed the usability and applicability of the application.

The form for the group of nurses comprised the content of prenatal, childbirth, puerperium and breastfeeding that made up the application, with the following aspects being assessed: clarity of language, relevance, and practical importance.

The form directed to ICT experts assessed "Screen organization", "Screen interface", "System content" and "Technical" referring to functionality - allows ease of use and precision in execution its functions; reliability - reacts appropriately when failures occur and informs users of invalid data entry; efficiency - the execution time and the resources made available are adequate; usability - it is easy to understand the concept and its applicability as well as learn to use it.[17]

For each content presented in the form, a five-point Likert-type scale was inserted: 1 = totally inadequate; 2 = moderately inadequate; 3 = level of adequacy that resembles that of inadequacy; 4 = moderately adequate; 5 = totally adequate.[18]

When experts did not agree with any item in the application, it was possible to propose a new statement or a new title to the menu, recommend the inclusion of some additional information, or suggest adding a new item.[18] Two Delphi rounds were completed for all experts, which were completed after unanimous agreement.

The data were organized in Microsoft Excel® 2016, double-typed, in order to guarantee reliability of the inserted data. Content Validity Index (CVI) was calculated considering the number of experts who participated in the study and the acceptable CVI value for each item, which varied between 0.80 and 1.00. It is noteworthy that the minimum acceptable score for content validity was 0.80.[14]

The Reliability Index (reliability) or inter-rater agreement (IRA) was also calculated, considering as ideal, for both, values equal to or greater than 0.80. Additionally, when comparing the two Delphi phases, the Mann-Whitney non-parametric test was used, in order to verify whether the results of Delphi 2 were more satisfactory than in Delphi 1 ((comparing the Content Validity Index of the domains and various aspects of the questionnaire). The level of significance was 5%.[19]

The application was developed in a way compatible with Android operating system devices in version 1.0. The choice was made because this, in the Brazilian reality, is the type of system compatible with most cell phones so that more pregnant women can have access to the technological instrument.[20]

Results

For the application development, 92 articles were selected for reading in full, of which 29 were included in the study. It was found that most studies were found in MEDLINE (60%), published from 2016 (34%), carried out abroad, whose language was English (73%).

It was found that the articles contained the following information that could compose a mobile application to promote the care of women during pregnancy: physiological changes in pregnancy and development of the fetus; complaints in the pregnant and puerperal period; use of supplements, vaccines, physical activity and weight gain; pregnant women's rights, childbirth, benefits of humanized childbirth and birth, puerperium, breastfeeding; prenatal doubts.

With access to *Gestação Saudável* , users will browse the interfaces to obtain health information regarding prenatal care, childbirth, the puerperium and breastfeeding. Pregnant women will be able to ask questions during the entire gestational period through the contact us menu. Thus, to ensure communication, registration with Google and hosting of the application was made so that it works both offline and online.

The home screen has a functionality to access a menu with seven main options: information on pregnancy and prenatal care, guidance on childbirth, puerperium, breastfeeding, date of consultations, pregnant women's virtual booklet and contact us (Figures 2 and 3).

In the first link, "information about pregnancy and prenatal care", users will have access to information about the pregnancy's physiological changes and the development of the fetus by trimester of pregnancy, in addition to photos that illustrate fetus. This section also provides information on the main complaints during pregnancy, use of supplements, vaccines, physical activity, weight gain, and pregnant women's rights.

In the second hyperlink, "guidelines on childbirth", pregnant women will learn about the benefits of humanized childbirth, as well as the ten items of good practices in childbirth and birth, with emphasis on the childbirth plan elaboration.

The third icon, "puerperium", provides guidance for women, such as food, breast care, lower limb pain, hygiene, fluid intake, vaginal bleeding, signs of infections, reproductive planning and post-

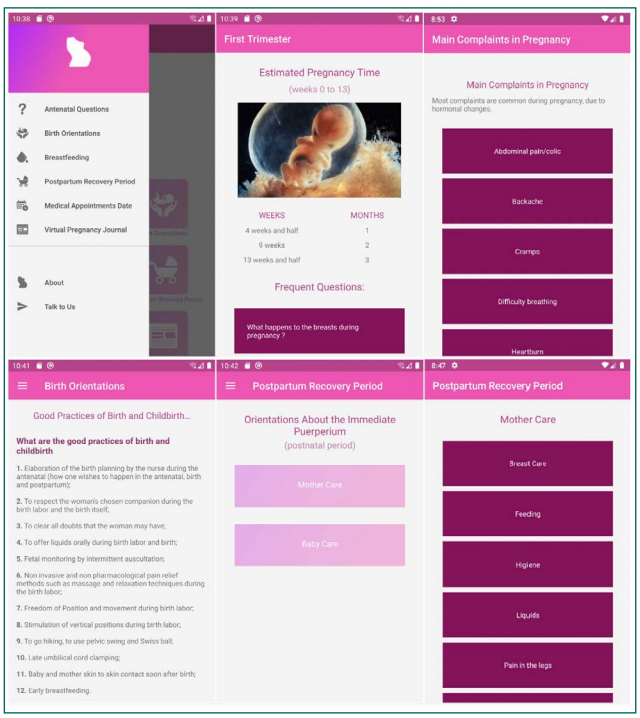

Figure 2. Graphical representation of the screens of the *Gravidez Saudável* application

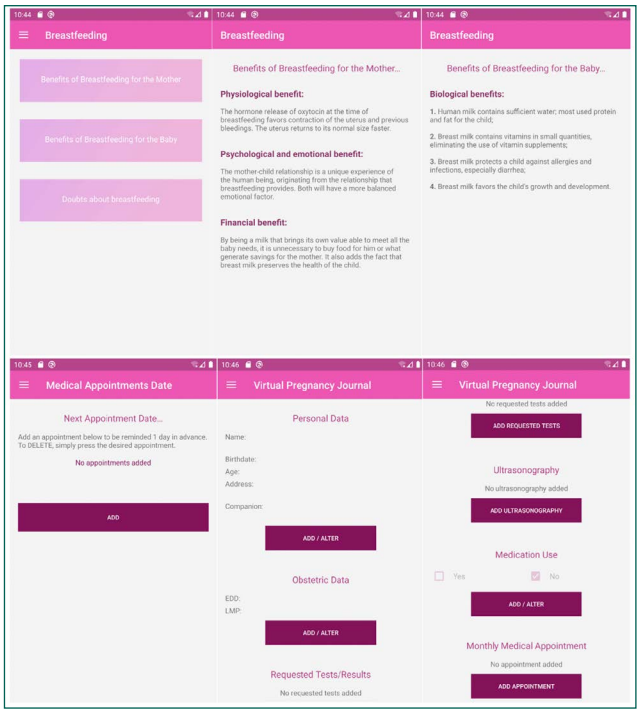

Figure 3. Graphical representation of the screens of the *Gestação Saudável* application

partum depression. As for newborns, it reinforces information about growth and development consultations, hygiene, cleaning the umbilical stump, neonatal screening tests and vaccines.

The fourth option, "breastfeeding", shows benefits of breastfeeding for mothers, newborns and the main doubts about breastfeeding.

The fifth button, "consultation date, alarm clock", will serve to record the date to the time of a prenatal consultation, in which, with 24 hours before consultation, pregnant women will be remembered through alarm clock.

The sixth icon, "pregnant women's virtual booklet" screen, will allow women to record their own health information collected at each consultation, store it and track it when necessary.

The seventh link, "contact us", has innovative characteristics, since women will be informed about the possibility of sending questions about pregnancy, through messages/email, to health professionals who will be part of the Matrixing of the Extended Nucleus of Family Health and Primary Care team (NASF-AB - *Matriciamento do Núcleo Ampliado de Saúde da Família e Atenção Básica*) of the municipality of Parnamirim/RN (site of the research). To this end, through the link in the application, pregnant women will have access to an institutional e-mail from the health department, which professionals who are inserted in NASF-AB will see during their work hours.

The NASF-AB in this municipality is composed of a nurse, psychologist, nutritionist, doctor, physical educator, social worker, and occupational therapist. They will answer the questions asked by pregnant women via email, Monday to Friday, at the following times: 08:00 a.m. to 12:00 p.m. and 14:00 p.m. to 17:00 p.m.. As these professionals do not work on duty, questions sent outside office hours will be answered the next day. On the other hand, the questions that will be asked on Saturdays, Sundays or holidays will have their answers until the next business day. As for the research participants who do not have email, they will be guided and helped by the researchers to make an email at the time of the installation of the application on a mobile phone. Health care strategies such as this can bring greater safety to women, thus reducing the risk of complications for them and the fetus. It is emphasized that the application can be installed on any mobile and location, not needing to be part of the research. Thus, any pregnant woman can send questions and receive answers.

The expert nurses who validated the application regarding content were mostly women (70%), with ages ranging from 30 to 40 years (60%), doctors or masters (60%) and that act only in teaching (70%). These assessed 16 items related to the application, which are described in Table 1.

In the first Delphi round, expert nurses suggested adjustments in 6 of the 16 items assessed, described in Table 1. Modifications were advised on screens two, five and seven regarding to language and content. The text was amended to show that not all women present breast changes in the first trimester of pregnancy and that it is important to wear sunscreen and hat during prolonged exposure to the sun, in order to avoid spots on the skin; include that not all pregnant women will feel the movements of the fetus at 16 weeks of gestation; and add, in the

Table 1. Agreement of nurse-midwives about the items of the *Gestação Saudável* application of the two Delphi rounds

Item	CVI item*			IRA**	
	Delphi 1	Delphi 2	P value***	Delphi 1	Delphi 2
Screen 1 - Welcome and congratulations for pregnancy					
I1	0.963	0.998	0.001	0.900	0.920
I2	0.912	1.000			
I3	0.941	1.000			
Screen 2 - Doubts of the first trimester of pregnancy					
I1	0.726	0.986	0.046	1.000	1.000
I2	0.707	1.000			
I3	0.852	0.978			
Screen 3 - Doubts of the second trimester of pregnancy					
I1	0.852	0.997	0.035	0.900	0.990
I2	0.951	0.993			
I3	0.981	1.000			
Screen 4 - Doubts of the third trimester of pregnancy					
I1	0.870	0.907	0.038	0.890	0.992
I2	0.852	0.990			
I3	0.963	1.000			
Screen 5 - Main complaints in pregnancy					
I1	0.753	0.979	0.001	1.000	1.000
I2	0.870	0.981			
I3	0.923	0.969			
Screen 6 - Use of supplements					
I1	0.901	0.901	0.001	0.897	0.989
I2	0.844	0.963			
I3	0.826	0.944			
Screen 7 - Vaccines in pregnancy					
I1	0.701	0.969	0.023	0.902	0.989
I2	0.844	0.963			
I3	0.826	0.944			
Screen 8 - The importance of physical activity in pregnancy					
I1	0.801	0.963	0.042	0.900	1.000
I2	0.844	0.963			
I3	0.826	0.994			
Screen 9 – Weight control in pregnancy					
I1	0.901	0.963	0.012	1.000	1.000
I2	0.844	1.000			
I3	0.826	0.944			
Screen 10 - Women's rights					
I1	0.897	0.984	0.001	0.904	0.989
I2	0.845	0.973			
I3	0.826	0.994			
Screen 11 - Guidelines on childbirth					
I1	0.897	1.000	0.012	0.948	1.000
I2	0.845	1.000			
I3	0.826	1.000			
Screen 12 - Good practices of childbirth and birth					
I1	0.818	1.000	0.001	0.870	0.980
I2	0.835	1.000			
I3	0.821	1.000			
Screen 13 - The benefits of breastfeeding					
I1	0.897	0.984	0.001	0.924	1.000
I2	0.845	0.973			
I3	0.826	0.994			
Screen 14 - Immediate puerperium					
I1	0.897	0.984	0.001	0.980	1.000
I2	0.845	0.973			
I3	0.826	0.994			
Screen 15 - Alarm clock with date and time					
I1	0.897	0.984	0.001	1.000	1.000
I2	0.848	0.973			
I3	0.831	0.994			
Screen 16 - Virtual notebook of pregnant women					
I1	0.719	0.964	0.001	1.000	1.000
I2	0.725	0.973			
I3	0.816	0.994			

*CVI - Content Validity Index; **IRA - Inter-rater Agreement Index; ***Mann-Whitney test; I1- Clear, understandable and appropriate language; I2- Relevant content; I3- Practical importance.

list of the pregnant women's virtual booklet, the examination of hemoglobin electrophoresis.

ICT experts, who validated the application for content, were mostly men (89%) with ages ranging from 30 to 40 years (78%) and who held a doctorate or master's degree (76%). Only in the screen interface dimension, in the usability item (Table 2), it was suggested modification in relation to the color of one of the screens, which was dark, which made it difficult to read the content. The application was terminated with 111 screens.

Table 2. Agreement of Information and Communication Technology judges about the items of the *Gravidez Saudável* application of the two Delphi rounds

Item	CVI Item*			IRA**	
	Delphi 1	Delphi 2	P value***	Delphi 1	Delphi 2
1. Screen organization					
Functionality	0.944	1.000	0.001	0.923	1.000
Reliability	0.921	0.991			
Efficiency	0.895	0.997			
Usability	0.913	1.000			
2. Screen interface					
Functionality	0.929	1.000	0.047	0.987	1.000
Reliability	0.901	1.000			
Efficiency	0.864	1.000			
Usability	0.738	0.991			
3. System content					
Functionality	0.944	1.000	0.029	1.000	1.000
Reliability	0.911	0.992			
Efficiency	0.921	0.991			
Usability	0.896	1.000			
4. Technical					
Functionality	0.825	0.999	0.019	1.000	1.000
Reliability	0.824	1.000			
Efficiency	0.821	1.000			
Usability	0.945	1.000			

*CVI - Content Validity Index; **IRA - Inter-rater Agreement Index; ***Mann-Whitney test.

Discussion

Mobile apps have gained traction in recent years in healthcare. Online stores offer a wide variety of options, which grow every day and range from fitness systems to monitoring and controlling the most diverse diseases. Therefore, when well designed and

used, they are didactic instruments that can bring benefits to the population and health professionals,[6] faster access of users to health services, speed in laboratory and imaging tests, diagnosis and treatment of diseases.[2]

The *Gestação Saúdável* application was developed with the purpose of facilitating access to pregnant women about important information during the pregnancy-puerperal cycle phase, helping them to mitigate any doubts that may arise during this process, facilitating contact with health professionals, adherence to prenatal consultations, consequently mitigating the risks of maternal mobility due to preventable causes.

Application use increases pregnant women's satisfaction with prenatal care and promotes normal childbirth and safe motherhood, thus reducing maternal morbidity and mortality. They are useful in monitoring changes – such as hypertension, overweight and maternal anxiety – and in adhering to the consumption of varied and healthy foods, being appropriate instruments to encourage the self-care practices of pregnant women.[21-25] The strengthening of self-care by pregnant women was emphasized in several items in the *Gestação Saudável* application, especially in the use of supplements, in the practice of physical activity and in weight control.

In prenatal follow-up, the use of applications allowed women to face barriers to access to care, promoted an increase in the frequency of consultations and helped identify the health risks of pregnant women, collaborating with a healthy pregnancy, childbirth and birth.[5-7]

The use of mobile applications has also been directed to the group of women in high-risk prenatal care, as described in quantitative research developed in the United States, using the paradigm method of behavioral decision research. Sixteen pregnant women were recruited from an outpatient clinic of a major academic hospital specialized in high-risk pregnancy, in order to test the My Healthy Pregnancy application, which aimed to reduce the rates of premature births. At the end of the research, it was observed that this instrument is an effective method to follow high-risk pregnant women up, because a regular follow-up of pregnant women, through the application and face-to-face consultations, helped in the early identification of risk factors for premature childbirth and, consequently, decreased childbirth rates before 37 weeks of gestation.[6]

Mobile applications have also been developed to support women in the puerperal cycle, especially in breastfeeding support. When assessing the usability and usefulness of a mobile phone application entitled *Moom Mãe*, developed in Thailand through a quantitative and qualitative research, with a sample of 21 women, an increase in the rate of nursing mothers in exclusive breastfeeding and delaying early weaning.[26] This result is in line with a prospective and observational study developed with eight women in Quezon city, Philippines, with a mobile application to promote and improve breastfeeding, where positive repercussions were found for women and their partners, because, in addition to records on breastfeeding, the device had addresses of comfortable public places for practice, clarified doubts about milk donation and provided link of communication between milk banks and the human milk collection station.[21]

Educational applications are valid in supporting women in the postpartum period, since they help in the identification of non-physiological change and care during the puerperal period. [21] With this, it is believed that the *Gestação Saudável* application is of great relevance, which also covers the puerperal cycle, enabling these women to be better adapted in the puerperium phase, including guidance regarding newborn care, contributing to the improvement of maternal and child health indicators.

The scope and comprehensiveness of contents in the *Gestação Saudável* application stands out, encompassing the pregnancy cycle, labor, puerperium and care for newborns, avoiding compartmentalized care. The contact us menu emerges as another great differential, enabling an approximation between patient/professional and facilitating access to health services.

To elaborate this application, we initially sought to identify, through a literature review, the main information that could make up a mobile application to promote the care of women in pregnancy and

then its content validation by experts. It is emphasized that the development of mobile applications, in a coherent and appropriate manner, presupposes the identification of users' real needs and, later, their validation.[20-22]

With regard to content validation, it can be observed, through expert assessment – nurse-midwives – that the application offers clear, understandable and appropriate language, relevant content and practical importance. Content validation of *Gestação Saudável* showed its reliability through CVI after the second Delphi round, and this index was adequate for all items assessed by judges. The ideal IRA showed that there was homogeneity in the assessments performed by experts. With the Mann-Whitney test, evidence of statistical difference of Delphi 1 with 2 for each screen was observed, identifying a better assessment in Delphi 2.

Appropriate CVIs demonstrated that the content covered in the application and the technical part of the system are reliable, proving to be valid. With the reliability presented, it is possible to indicate its use for pregnant women as a way to contribute to their knowledge and improvement of prenatal care performed, since it can facilitate communication between professionals and users, increase their support in prenatal consultations, providing opportunities for early diagnosis of complications that may arise and focus on the reduction of maternal and perinatal morbidity and mortality due to preventable causes.

The validation results of the instrument in this study are similar to those of a study conducted in northeastern Brazil on booklet validation for pregnant women submitted to spinal anesthesia in cesarean surgery, in which items related to language and content were assessed, which presented adequate CVIs. In the course of a instrument's positive effects, the language used needs to be clear and understandable by the target audience, in addition to presenting practical relevance.[27]

For ICT experts, with regard to screen organization and interface and system content, the device presents clear, fast-access and easy-to-handle features for users of the technology. Thus, the importance of the feasibility of the technology is highlighted. These experts positively assessed the items' functionality, reliability, efficiency and usability for pregnant women, demonstrating that the information provided in the application was considered pertinent, and can be used by pregnant women as a health promotion instrument in the pregnancy-puerperal period, which was verified through the CVI value presented. In Delphi 2, all items assessed by these professionals presented CVIs suitable for content validity and ideal IRA. This data support methodological research conducted in Brazil, which built and validated an educational technology for pregnant women according to the same criteria. The results of the instrument assessment by 47 experts, demonstrated adequate CVIs.[28] Thus, the *Gestação Saudável* application is also presented with excellence legitimacy and credibility in its technological resource.

The validation of educational technologies by professionals with experience in assessing content in applications is important, since they have a keener look at aspects that can influence the process of learning, empowerment, and self-care.[29-31] It should be noted that the result of this study obtained agreement among experts.

In the development of mobile applications, it is necessary to include sufficient information, clear concepts and coherence in relation to the theme to be worked on to ensure its efficiency.[28] In this study, there was concern to make clear questions and answers using simple vocabulary and sufficient information, through short texts to avoid ambiguity and allow message transmission and gathering. This data corroborates research findings about the validation of an educational manual for companions during pregnancy, which obtained a satisfactory assessment regarding language clarity, objectivity and attractiveness.[29,30]

Although the application content validation indicates the reliability of the information and the importance of subjects addressed for the knowledge of women who are in the gestational period, the research presented as a limitation the non-validation of the instrument regarding the functionality and usability by pregnant women, which could imply the restriction of its use due to difficulties in the

handling of menus and lack of understanding in relation to the information provided.

Conclusion

The adequate general CVI among experts evidences the *Gestação Saúdável* application as a instrument that presents reliable information to be used in care during the pregnancy-puerperal period, which can enhance pregnant women's knowledge about pregnancy and puerperium, encourage self-care and guidance in some newborn care, strengthen the adoption of prenatal consultations and accessibility to contact with professionals. It is noteworthy that the application developed allows knowledge acquisition about reproductive rights and participation in the childbirth plan elaboration; personal data storage, consultations and laboratory tests and images; remember the dates of prenatal consultations and clarify questions by the contact us menu. Furthermore, this technology may contribute to the practice of breastfeeding, newborn care, reinforcing information on growth and development consultations, hygiene, umbilical stump cleaning, neonatal screening tests and vaccination. These contents were validated with appropriate CVI by experts. The technology developed can also be used by health professionals as an educational instrument, since the contents offered in the application are important strategies for women to know the transformations that occur in the body, the warning signs and the relevance of breastfeeding and care for newborns. The information provided through the application may be a means for strengthening reproductive rights.

Collaborations

Souza FMLC, Santos WN, Dantas JC, Sousa HRA, Moreira OAA and Silva RAR contributed to the study conception, data analysis and interpretation, writing of the article, relevant critical review of intellectual content and approval of the final version to be published.

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