

Rumo à Maternidade: Validation of a Telehealth Application for Pregnancy Care

Maiara Oliveira, Máyla Medeiros, Leonandro Gurgel, Talita Martins, Luiza de Araújo, Anna Giselle Rodrigues, Adriana Magalhães, Maria Micussi

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Abstract

Background: Pregnancy, labor, and the puerperium are periods of great expectation for women and their families. Anxiety during this phase may lead to an early hospital visit before the active phase of labor.

Objective: This study aimed to develop and validate a tele-educational mobile application for pregnant women in their last trimester and assess their anxiety levels.

Methods: This validation study included 40 volunteers: 10 obstetric professionals, 10 technology professionals, and 20 pregnant women with a gestational age of ≥35 weeks, divided into primiparous (PG) and multiparous (MG) groups. Health professionals assessed content validity using the Content Validity Index (CVI), while technology professionals evaluated the software's appearance through a questionnaire. Pregnant women rated usability using the System Usability Scale (SUS), and anxiety levels were measured before and after app use using the Hamilton Anxiety Scale (HAS). The app, Rumo à Maternidade, was developed with React Native and includes three interfaces: Educational, Symptoms Record, and My Pregnancy. Descriptive statistics and a paired t-test were used for data analysis.

Results: The final CVI scores were 0.91 for content and 0.78 for appearance. No significant difference was found in usability scores between groups (PG: 92.68 ± 0.55 ; MG: 90.50 ± 0.58 ; $p = 0.53$). HAS scores showed significant change after app use in PG (before = 22.89 ± 9.47 , after = 15.40 ± 6.83 , $p = 0.001$) and MG (before = 19.00 ± 9.20 , after = 15.60 ± 6.22 , $p = 0.001$).

Conclusions: The mobile app Rumo à Maternidade, developed and validated in Portuguese in Brazil, is a well-accepted tool for health education during the third trimester of pregnancy, aiding in labor identification.

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Original Manuscript

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Keywords: Women's Health; Pregnant Women; Labor; Telemedicine.

Introduction

In recent years, advancements in information and communication technology have transformed healthcare, enhancing users' quality of life and enabling continuous health monitoring (1). Among these innovations, telecare, telehealth, and mobile health have emerged as widely used strategies (2). A key component of telehealth, tele-education has gained prominence in providing continuous education, facilitating regular clinical assessments, promoting self-care, and offering guidance in unforeseen situations (3,4). Several studies have explored this approach in various health conditions, including high-risk pregnancies (5,6).

Even today, accurately diagnosing the onset of labor remains a challenge in obstetrics (7). During normal labor, regular and painful uterine contractions are expected to promote progressive cervical dilation and effacement, accompanied by fetal descent and eventual expulsion (8). However, the perception of this process can vary widely among women, and emotional factors, such as anxiety, may also hinder the identification of the exact moment labor begins (9). This difficulty contributes to premature hospital admissions before an accurate diagnosis of the active phase of labor, leading to early hospital discharges and frequent readmissions (10).

One of the recommendations from health organizations is that pregnant women should be admitted to maternity units during the active phase of labor, thereby reducing hospitalization time (8). In addition to decreasing hospital stays, admission during the active phase reduces the risk of misdiagnosing labor dystocia, unnecessary interventions, and operative deliveries (9). To prevent the premature hospitalization of low-risk pregnant women during the latent phase, several global initiatives have been implemented, including recommendations from institutions such as World Health Organization (WHO) and the Brazilian Ministry of Health (8,9).

Integrating educational strategies through digital tools has the potential to improve healthcare outcomes for pregnant women. While telehealth enhances health management and patient engagement, its impact on reducing hospital readmissions remains inconclusive (1,2,4). Additionally, no previous studies have been identified that describe the development of a platform indirectly targeting these outcomes.

This study hypothesizes that developing a mobile application can improve health education for pregnant women in their third trimester and help minimize postpartum emotional distress. Therefore, this study aimed to validate the content of a digital app designed to assist pregnant women in identifying labor symptoms and to assess anxiety levels during pregnancy.

Methods

Study design

This feasibility study employed a mixed-methods approach to develop and validate the app using an evidence-based, audience-centered framework. The Intervention Mapping Protocol (IMP) (11) and the RAND/UCLA Appropriateness Method (RAM) (18) were adapted and implemented. While IMP addresses general and interdisciplinary aspects, RAM focuses on elements relevant to both healthcare professionals and patients (11,12).

App Development

A literature review was conducted to gather information on physiological changes during pregnancy and symptoms related to labor. Additionally, an analysis of existing pregnancy-related mobile applications revealed a significant gap in technological tools that comprehensively address third-trimester symptoms and labor. Most available apps focus primarily on fetal development or provide only limited tracking of uterine contractions.

The app development team comprised a healthcare professional, a technology specialist, and a design expert. Weekly meetings were held to define app functionalities, integrating insights from both clinical practice and the literature. The primary goal of these meetings was to consolidate professional input and guide the app's development process.

To establish the app's theoretical foundation, the healthcare team reviewed recommendations from the WHO and the Brazilian Ministry of Health, along with systematic reviews and meta-analyses from databases such as Medline, Open Science, and Cochrane. Each topic related to the last trimester of pregnancy and labor was thoroughly researched and documented. The weekly meetings facilitated discussions to refine this information into a structured format.

After defining the content, the technological team developed the app's interfaces, while the design team created images, GIFs, and videos for the educational sections. The entire team collaborated to ensure the material's accuracy and user-friendliness.

The app was built using React Native and initially launched for the Android operating system. Following the release of a test version, final adjustments were made based on study group feedback, leading to the deployment of the final version.

Validation

The validation process was conducted in three sequential stages: (1) content assessment, (2) appearance evaluation, and (3) usability testing. The study sample included three distinct groups: (i) obstetric professionals (e.g., obstetricians, nurses, midwives, physiotherapists), (ii) technology professionals, and (iii) pregnant women. A total of 40 participants were recruited, comprising 20 professionals (10 from each field) and 20 pregnant women. Participants were selected through convenience sampling, following established research protocols (19).

Content Validity Index

Health professionals were contacted via email or telephone and accessed the Rumor à Maternidade app on their mobile phones after providing informed consent. Pregnant women were invited to participate during antenatal care visits, where they received study details from healthcare professionals, signed informed consent forms, and used the app on research-provided devices during a 20-minute session. Afterward, all participants completed a Google Forms® questionnaire, collecting educational and professional background data for professionals and demographic and obstetric information for pregnant women.

Healthcare professionals assessed the app's content in key areas, including uterine contractions, amniotic fluid release, mucous plug discharge, lower back and abdominal pain, fetal movements, heart rate monitoring, high blood pressure symptoms, and general labor information. Responses were recorded using a Likert scale from 1 (completely disagree) to 5 (completely agree). The Content Validity Index (CVI) (13) was used to measure inter-rater agreement for each content field.

The CVI methodology involves expert evaluation of individual items to determine their relevance to the constructs being measured. The number of evaluators (raters) ranges from a minimum of two to a maximum of 25, while rating categories vary from two to seven. A final CVI score exceeding 0.78—assessed by at least six raters—is considered acceptable for content validation (11,12).

To ensure participation in the study, professionals were required to accumulate a minimum of 3 points according to the following criteria: healthcare professionals with over 10 years of obstetric experience and specialization received 4 points; those with more than 5 years of experience and specialization earned 3 points; individuals with more than 5 years of practice were assigned 2 points; and renowned professionals were awarded 1 point.

Appearance Validity

The appearance validity assessment was conducted using a six-question form adapted to the CVI. The CVI quantifies the proportion of judges who agree on specific aspects of the instrument and its items, enabling both individual item analysis and overall instrument evaluation. Responses were recorded on a five-point Likert scale, consistent with the previous questionnaire, ranging from "Strongly Disagree" to "Strongly Agree," with statements alternating between positive and negative aspects.

The number of judges was considered during item evaluation. For assessments with five or fewer judges, unanimous agreement was deemed representative. When six or more judges participated, a minimum agreement rate of 0.78 was required for item inclusion (13).

Technology professionals were included based on a scoring system derived from a previous validation study on mobile apps (11). The criteria were as follows: prior experience in health app development (4 points), experience in React Native technology app development (3 points), experience in Front-End software development (2 points), and possession of a diploma in information or computational technology (1 point).

Usability Assessments

The usability evaluation was conducted with specific criteria for volunteer inclusion: participants had to be aged 18 or older, at least 35 weeks gestation, pregnant with a single fetus, anticipating a vaginal delivery, or already in active labor, with no prior indications for a cesarean section. Additionally, participants needed to understand both written and verbal instructions, reside in Natal/RN or its vicinity, and have a travel time of approximately 30 minutes to the maternity ward. Recruitment occurred at the antenatal care department of Maternidade-Escola Januário Cicco in Natal/RN. Volunteers were evenly divided into two groups: primiparous (PG = 10) and multiparous women (MG = 10).

The app's usability was evaluated using the System Usability Scale (SUS), which has been translated and validated in Brazilian Portuguese. The SUS comprises 10 questions, each rated on a scale from 1 to 5, where 1 indicates 'Completely Disagree' and 5 indicates 'Completely Agree.' For odd-numbered items (1, 3, 5, 7, 9), the score was calculated by subtracting 1 from the user's response, while for even-numbered items (2, 4, 6, 8, and 10), the score was calculated by subtracting the user's response from 5 (i.e., $5 - x$). The scores for all 10 questions were then summed and multiplied by 2.5. This methodology is well-established, with an average System Usability Score benchmark of 68 points within the research community (14).

The Rumo à Maternidade mobile app was developed with three main interfaces: 'Educational,' 'Symptoms Record,' and 'My Pregnancy.' Figure 01 illustrates the initial

screen, displaying all three interfaces. In the 'Educational' interface (Figure 2), users can access information about labor phases and related symptoms. The 'Symptoms Record' section enables users to input their current symptoms, guided by a quiz algorithm that offers guidance based on previously entered symptoms, including amniotic fluid and mucous plug release, painful sensations, fetal movement, maternal heart rate, and uterine contractions (Figure 3). The 'My Pregnancy' interface (Figure 4) displays the woman's general information, such as name, gestational age, and previously recorded symptoms, including the contraction count.

Figure 1 - Home screen of the app to access the 'Education', 'Symptoms' and 'My Pregnancy' interfaces.

Figure 2 - Screen of the Educational interface with the stages of labor.

Figure 3 - Screen of the Symptoms menu.

Figure 4 - Screen of the Uterine Contraction Counter.

Outcomes measures

Anxiety was assessed using the Hamilton Anxiety Scale (HAS) (15), one of the first rating scales developed to measure the severity of anxiety symptoms. The HAS remains widely used in both clinical and research settings (15). The scale consists of 14 items, each scored from 0 to 4, with a total possible score of 56. A higher score indicates a greater level of anxiety (15). All women participating in the usability study were evaluated using the HAS. The initial assessment was conducted during the third trimester of pregnancy, followed by a reassessment within 48 hours postpartum.

Statistical Analysis

The sample data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.0. Descriptive statistics were used to characterize demographic, clinical, and obstetrical data. The CVI and appearance questionnaire results were presented as total answer values, converted to percentages.

The SUS score was calculated by adjusting odd-numbered item values downward by 1 point and even-numbered item values downward by 5 points. After these adjustments, the total scale points were multiplied by 2.5 to obtain the overall system usability score.

To compare anxiety scores before and after using the application, the paired Student's t-test was applied for both the primiparous and multiparous groups. The unpaired Student's t-test was used to compare the final anxiety scores between the primiparous and multiparous groups.

Ethics Approval Descriptive Characteristics

This study was approved by the Research Ethics Committee of the University Hospital Onofre Lopes of the Federal University of Rio Grande do Norte (CAAE: 38145320.2.0000.5537). All research participants voluntarily agreed to participate and signed the free and informed consent form. The study adhered to the ethical principles outlined in the Declaration of Helsinki.

Results

Content and Appearance Validity

A total of 20 volunteers were interviewed for content and appearance validity. Among the obstetrical health professionals, 30% were medical practitioners, 40% were physiotherapists, and 30% were nurses. Of them, 90% were female, with an average of

7.30 $\pm$ 4.25 years of experience in obstetrical centers, and 60% worked in both public and private health systems. Among the technology professionals, 50% were female, 70% held degrees in information technology, 20% in computer engineering, and 10% in software engineering. Additionally, 40% of them had experience developing health-related mobile applications.

In the content assessment, two professional suggestions were incorporated by the research group. One volunteer recommended modifying technical terminology to enhance public understanding, such as replacing 'hemorrhage' with 'bleeding'. Additional suggestions included the inclusion of symptoms like 'blurred vision' and 'headache'. The final CVI for expert agreement on the theoretical relevance of the content was 0.91. Among the evaluated domains, the 'fetal movement' section received the lowest individual mean score (4.3 $\pm$ 1.05) on a scale from 0 to 5, while 'heart' rate and 'other symptoms' achieved the highest averages (4.8 $\pm$ 0.42).

For the appearance assessment, only one suggestion was made regarding the reduction of informative texts, which was accepted by the research group. Most pregnant participants suggested enlarging the pain visual scale to improve readability and user experience. Additionally, one participant proposed numbering the labor phase images for enhanced clarity, while others recommended adding a domain for fetal exam records. However, the latter was not incorporated, as it was deemed unrelated to the primary objective of the application. The appearance assessment resulted in a final score of 0.78, which was considered favorable. The correct use of technological resources domain received the lowest individual average score (3.72 $\pm$ 0.87), whereas the easy-to-understand language question obtained the highest score (4.18 $\pm$ 0.97).

Table 1 presents the individual field scores, along with the total scores for both content and appearance validation.

Table 1. Content and appearance validity Index result (n = 20).

	Average $\pm$ SD
Content Validity	
Labor phases	4.60 $\pm$ 0.96
Uterine contractions	4.60 $\pm$ 0.69
Amniotic liquid release	4.60 $\pm$ 0.51
Mucous plug release	4.50 $\pm$ 0.97
Painful sensations	4.40 $\pm$ 0.96
Maternal heart frequency	4.80 $\pm$ 0.42
Fetal movement	4.30 $\pm$ 1.05
Other symptoms	4.80 $\pm$ 0.42
<i>Total</i>	36.60 $\pm$ 2.63
Appearance Validity	
Understandable language	4.18 $\pm$ 0.97
Correct utilization of resources	3.72 $\pm$ 0.87
Wide utilization of resources	3.90 $\pm$ 1.05
Attractive interface	4.00 $\pm$ 0.66
Ease of utilization	4.00 $\pm$ 0.99
Non-tiring informative offer	3.90 $\pm$ 1.10
<i>Total</i>	23.50 $\pm$ 3.73

Note: SD - Standard Deviation.

Usability test

The general characteristics of the usability participants showed no difference regarding age (PG = 27.47 ± 6.35 ; MG = 30.54 ± 4.74 ; $p = 0.63$) and gestational age (PG = 37 ± 1.08 ; MG = 37 ± 0.91 ; $p = 0.87$). Most participants had completed high school (PG = 80%; MG = 60%), had an income of up to one minimum wage (PG = 70%; MG = 60%), and did not receive labor education (PG = 60%; MG = 60%). Regarding the use of gestational health mobile applications, 50% had used one in the GP group, and 30% in the MG group.

There was no significant difference in the SUS score between the primiparous and multiparous groups. Among the affirmative statements, 'ease of utilization' received the highest individual average in both groups. Conversely, among the negative statements, the item 'clumsy to use' had the lowest score in both groups. Table 2 presents the individual values for each SUS item.

Table 2. System Usability Index results (n = 20)

Questions	PG	MG	P value
Likely frequently use the system	4.53 ± 0.92	4.22 ± 1.03	0.75
Unnecessarily complicated	0.95 ± 0.11	1.01 ± 0.08	0.32
Easy usage	4.98 ± 0.47	4.85 ± 0.38	0.72
Necessary help in using	2.30 ± 0.89	2.24 ± 1.04	0.55
Well-integrated functions	4.70 ± 0.55	4.72 ± 0.83	0.81
Presence of inconsistencies	1.22 ± 0.66	1.15 ± 0.52	0.45
Imagine that people will easily learn how to use	4.90 ± 0.56	4.81 ± 0.73	0.64
Clumsy to use	0.94 ± 0.41	1.05 ± 0.32	0.35
A feeling of confidence during the usage	4.89 ± 0.38	4.80 ± 0.44	0.81
Need to learn new information to use	1.52 ± 0.53	1.75 ± 0.41	0.34
Total	92.68 ± 0.55	90.50 ± 0.58	0.53

Note: PG – primiparous group. MG – multiparous group. Data presented as mean and standard deviation.

Anxiety assessment

It was observed that the primiparous group exhibited higher anxiety levels in the last trimester of pregnancy ($p < 0.001$), with a noticeable reduction in anxiety during the postpartum period ($p = 0.001$) in both groups (Table 3).

Table 3. Anxiety assessment results before and after using the app Rumor à Maternidade.

Groups	Before	After	P value
Primiparous	22.89 ± 9.47	15.40 ± 6.83	0.001*
Multiparous	19.00 ± 9.20	15.60 ± 6.22	0.001*

Note: Data presented as mean and standard deviation. *Statistically significant findings were observed in the paired Student's t-test ($p < 0.05$).

Discussion

Principal Results

This study aimed to develop and validate a mobile tool for use in the third trimester of pregnancy. The app was designed to provide the target audience with relevant information on labor and symptoms, contributing to the early identification of signs and symptoms of labor. The methodology followed an evidence-based approach and user-centered design, achieving satisfactory validity scores for content, appearance, and usability, regardless of parity.

Limitations

A potential limitation of this study is the cross-sectional evaluation of the app's usability, particularly regarding frequent use. This approach captures only a snapshot of the user experience and does not account for the long-term impact or sustained engagement with the app. Future longitudinal studies are needed to assess ongoing usage, knowledge acquisition over time, and the emotional impact on users. Additionally, no control group was included, which limits the ability to compare the effects of app usage on anxiety levels. Another limiting factor is that, in addition to the World Health Organization's labor assistance recommendations, the app also incorporated Brazilian guidelines. This may result in discrepancies in the outcomes due to differences in practices and regulations across countries.

Comparison with Prior Work

The proposed content of the app's domains was based on Brazilian guidelines, labor assistance recommendations, and World Health Organization protocols (8,9), which contributed to a high Content Validity Index score. The information sources incorporated are aligned with evidence-based clinical practices and were evaluated by professionals working directly in clinical settings to ensure these benefits. Obstetrical health professionals with both theoretical and practical experience, who have worked in both public and private health systems, were involved in the evaluation process. These systems have distinct characteristics that reflect the users' sociodemographic conditions.

The fetal movement component received the lowest individual average score among the app's fields. According to Heazel (2008) and Mangesi (2015), there are multiple definitions for decreased fetal movement, but none are universally accepted (16,17). The systematic review by Bellussi (2020) revealed that no objective method for counting fetal movements could be compared to simple subjective perception (18). Given this conflicting evidence, the researchers suggested relying on the subjective maternal perception of changes in fetal movement. On the other hand, the items "heart rate" and "other symptoms" received the highest scores, possibly due to their more direct and immediate clinical relevance in the context of obstetric monitoring.

In the appearance evaluation, ease of reading received the highest score from volunteers in communication technology, information, and computing. The item related to comprehensible language also received the highest score from the pregnant women, highlighting one of the main benefits of telehealth: the appropriation of technology for self-

care and the dissemination of technical-scientific knowledge in an accessible and easily understandable language (19).

The usability results demonstrate that, regardless of parity and prior knowledge about labor, the app was well accepted by users. Users felt capable of receiving information and independently recording symptoms, even without prior knowledge about labor. Mechael et al. (2010) state that higher usability rates provide better support for users (19). It is believed that the volunteers found the app easy to use and felt capable of receiving information and recording symptoms independently.

Additionally, a reduction in anxiety levels was observed in both primiparous and multiparous women postpartum. The findings of this study align with previous research that highlights the positive effects of antenatal education on maternal anxiety and birth outcomes, ultimately improving the overall birth experience and contributing to physical and emotional satisfaction with birth experiences (10,20-23).

Conclusions

In conclusion, the Rumo à Maternidade application, developed and validated for the Portuguese language in Brazil, has proven to be a usable tool with valid content and appearance. The app aligns with evidence-based practices and provides valuable information to support pregnant women. Future updates may integrate additional functions and expand language options to cater to a broader population, enhancing its accessibility and usability.

Conflicts of Interest

None declared.

Abbreviations

CVI: Content Validity Index
HAS: Hamilton Anxiety Scale
SUS: System Usability Scale
WHO: World Health Organization

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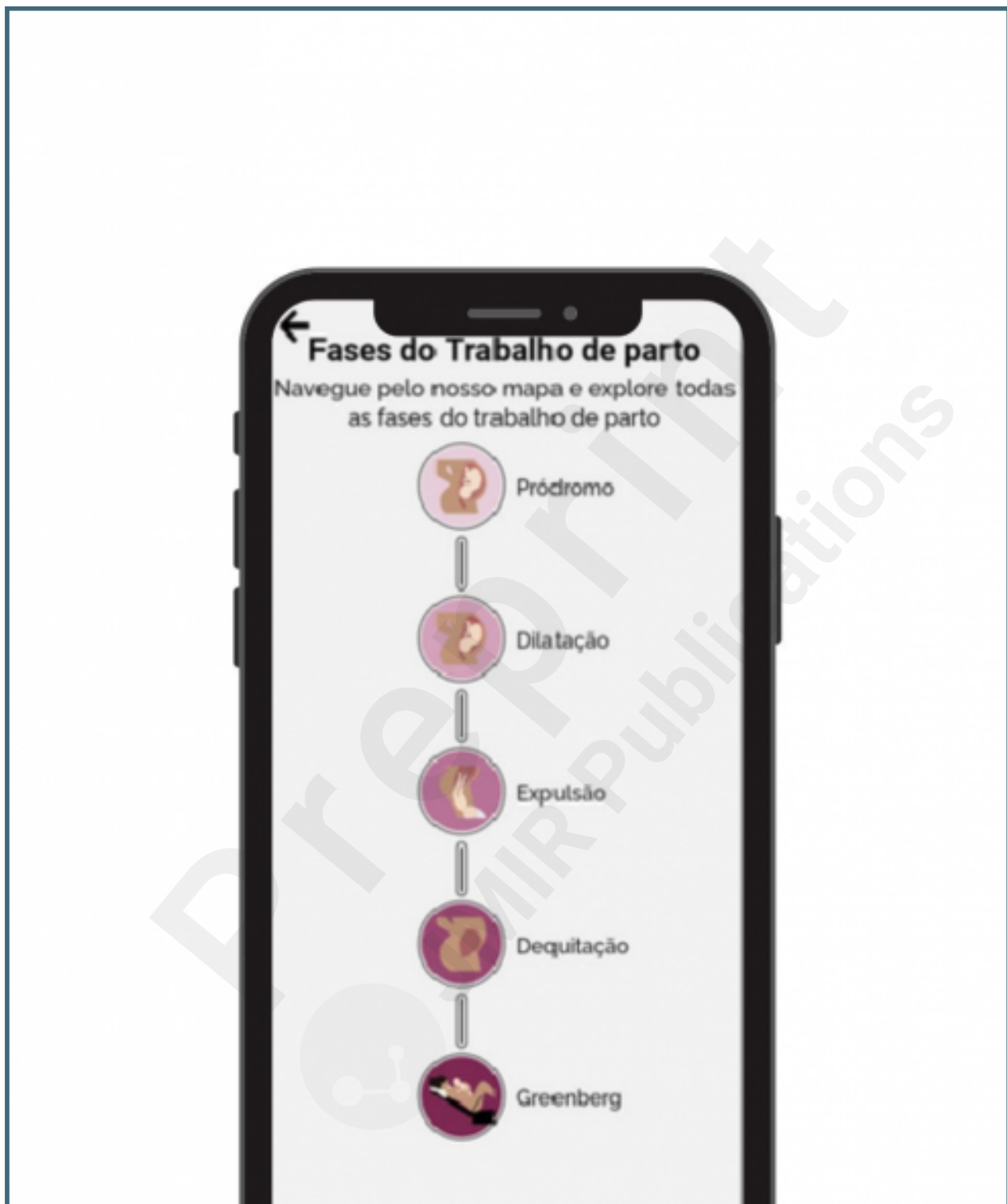
Supplementary Files

Figures

Home screen of the app to access the 'Education', 'Symptoms' and 'My Pregnancy' interfaces.



Screen of the Educational interface with the stages of labor.



Screen of the Symptoms interface.



Screen of the Uterine Contraction Counter.

