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Continence App: Construction and validation of a mobile application for postnatal urinary incontinence prevention



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ABSTRACT

Objective: Describing the Continence App development as an educational technology to promote adherence to pelvic floor muscle training and prevent urinary incontinence in postpartum women.

Study design: Study of technological production carried out in two stages: construction and validation. The first happened in four steps: modeling, navigation project, abstract design of the interface and implementation. In the validation phase 22 experts (11 health experts and 11 from the information technology/computing/communication areas) and 22 puerperal women were invited to evaluate the content and appearance of the education application. The content validity was analyzed through the Content Validity Index and the appearance validity through 75% minimum agreement in the items evaluated. The study was conducted during 2016 and 2017. For the content validation, the judges evaluated the following aspects: concepts and definitions used in the application, possibility of comprehension by the target audience and form of presentation. In order to validate the appearance, the installation, execution of the functions, objectives, usability, interface, practicality and interaction with the user were evaluated.

Results: Most of health experts were physiotherapists ($n=07$) and professionals with a PhD ($n=07$). Regarding the CVI, 100% of the evaluated items obtained values of 0.86 or greater. Most of information technology/computing/communication experts were male (81.8%) and of the information technology area (63.6%). Except for “restart sessions”, “ways of presenting suggestions”, “user interaction” and “motivates questioning”, all the other aspects received between 81.8% and 100% positive responses. All items evaluated by the target audience obtained a minimum of 94.3% positive responses from the participants. In this step, points for adjustment were identified in relation to the application content and interface, which were promptly corrected.

Conclusions: The application has been validated for use in clinical practice as an educational technology to promote adherence to pelvic floor muscle training and prevention of urinary incontinence in postpartum women.

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Introduction

Pregnancy and childbirth are known as significant risk factors for weakening and injury to the perineum and pelvic floor. The stretching and rupture of peripheral nerves, connective tissue and muscles may cause pelvic floor disorders such as urinary incontinence (UI) [1]. Approximately 50% of women lose some

of the support function of the pelvic floor due to childbirth [2], with a prevalence of major injuries to the pelvic floor muscles of 20–26% following vaginal delivery [3–5].

Pelvic floor muscle training (PFMT) remains a key factor in the prevention and treatment of UI. Considering that pelvic floor muscle (PFM) integrity appears to play an important role in the continence mechanism, there is a biological rationale to support the use of PFMT in preventing and treating UI in women [6]. Consequently, PFMT must be present in the routine care during pregnancy and after delivery, as recommended by the International Continence Society (ICS) [7]. Adherence is fundamental for the PFMT effect and a maintenance program should be recommended

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to ensure long-term effects [8,9]. Therefore, it is necessary to develop and implement interventions that are focused on the needs of the patient, minimizing the barriers and facilitating the implementation of PFMT [10].

Despite recent studies suggesting that mobile applications may facilitate public involvement in health promotion behaviors [11] and that they are becoming increasingly common [12,13], a study conducted on the Apple Store and Google Play by the authors between November 2016 and February 2017, using the keywords Urinary Incontinence, Kegel Exercises or PMFT in English, Spanish and Portuguese found only 15 apps. Of these, only eight worked without requiring sensors or electrodes connected to the smartphone and only one standardized its content according to the ICS, however, was not available in Portuguese and was not directed toward this target population. These results demonstrate the deficit of mobile apps related to this subject, especially in Portuguese and based on reliable scientific sources. Not surprisingly, because most app developers use unverified sources of medical information, recent publications have emphasized the importance of peer-review validation [14,15].

We believe that the development of an educational mobile app to help women perform PFMT, such as the Continenence App, would reduce adherence barriers and facilitate its execution by them. In this context, the aim of this study was to describe the development of the Continenence App as an educational technology to promote PFMT adherence and to prevent UI in postpartum women.

Materials and methods

The Continenence App was finalized, with all adjustments, in 2018. For its development, a technological production study was carried out in two stages: construction and validation [16], with the first stage consisting of four phases [17,18] (Fig. 1):

1a - Conceptual modeling: definition of the application's content and how it should be presented to the target audience

1b - Navigation project: the content generated previously was organized in indexes, scripts, access structures and images in order to facilitate its use by the user.

1c - Abstract interface design: definition of the system's appearance and specification of which interface objects the user can visualize.

1d - Implementation: performed by a software developer where all the content generated in the previous steps was transformed into computational language.

The validation stage (stage 2) of the Continenence App consisted of its evaluation by professionals who are specialists in the subject and by individuals that have the problem that it addresses [19]. In this phase, the Continenence app had its content (phase 2a) and appearance (phase 2b) evaluated by experts (healthcare providers and information technology, communications and computer science professionals) and by the target audience (postpartum women) (Fig. 1).

For the definition of an expert, the following criteria were adopted: "I) Possessing a specialized background of knowledge or skill; II) Extensive experience in that field of practice; III) Highly developed levels of pattern recognition; and IV) Acknowledgment by others" [20]. The selection of the experts was made through convenience and snowball samplings. The postpartum women were users of a tertiary maternity hospital in Ceará, Brazil (sampled by convenience) and were included in the sample if they: were 18 years of age or over; were in the immediate post-delivery period, had given birth to a full-term newborn vaginally, regardless of the number of previous deliveries, and had a cell phone or similar device compatible with the Continenence App.

The study was conducted during 2016 and 2017. For the data collection, three instruments were constructed using the "Google Forms" program: a consent form, participant's identification form and a questionnaire to evaluate educational software, which has response options on a Likert-type scale: "No", "Partially with MANY restrictions", "Partially", "Partially with FEW restrictions" and "Yes".

For the content validation (phase 2a), the judges evaluated the following aspects: concepts and definitions related to UI used in the application, ease of comprehension by the target audience and its form of presentation. In order to validate the appearance (phase 2b), the installation, execution of the functions, objectives, usability, interface, practicality and interaction with the user were evaluated.

The professionals were contacted by email and telephone. Those who agreed to participate in the study were emailed the link to the data collection form and were registered on the Android or iOS platforms to access the Continenence App. The puerperal women

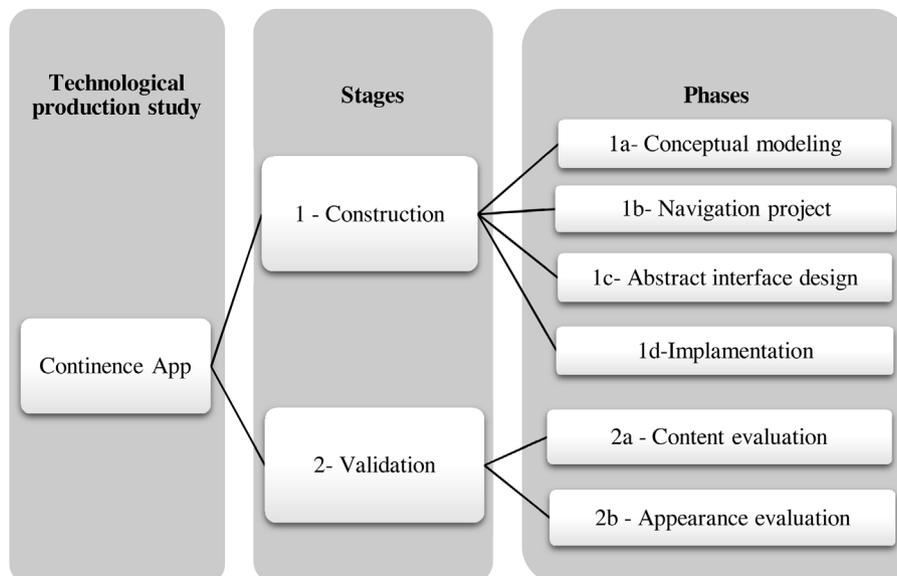


Fig. 1. Stages of Continenence App development.

were approached on the ward and, after signing the consent form, a Samsung Galaxy Tab E® tablet, with a 10.1 inch screen, a Quad Core 1.4 Ghz processor, an Android 4.0 operating system, a 7000 mA h battery and an internal memory of 8 GB containing the application was delivered to the participant. After a minimum of 20 min exploring the Continence App, the evaluation instrument was applied.

Data analysis was performed using the Statistical Package for the Social Sciences 22.0 for Windows. The Content Validity Index (CVI), which measures the proportion or percentage of judges who agree on an assessed aspect, was used to analyze the content validity of the application performed by the experts of the health area [21,22]. This was calculated from the sum of the items with positive evaluations divided by the number of responses, considering a CVI rate of not less than 0.78 as ideal [21,22]. Regarding the appearance validity performed by the experts in the technology area and by the target audience, a minimum of 75% of positive responses (partially with FEW restrictions and yes) was adopted for each item [23].

The study was submitted to and approved by the Ethics Committee for Research with Human Subjects of the two institutions involved (Federal University of Ceará and Maternidade Escola Assis Chateaubriand).

Results

Continence App construction process (stage 1)

The **conceptual modeling** (phase 1a) was based on a systematic review [24] performed by the authors. The findings were that PFMT was the intervention most used to prevent UI in the postpartum period. Accordingly, it was decided that PMFT would be the central intervention together with other components, such as education about the pelvic floor, the concept of UI, its types and risk factors, changes in lifestyle and positive reinforcement. These contents were approached using the Health Belief Model, which aims to develop knowledge in the target audience regarding the susceptibility to the occurrence of UI, its severity and the benefits of decision making, motivating them to adhere to the program proposed in the application (Table 1).

In the **navigation project** stage (phase 1b), the previously generated content was organized into four information cards (Fig. 2):

Card 1 - Knowing the Subject: addressed the form and functions of the organs and structures that make up the female pelvis, the risk factors for UI, its pathophysiology and the main types of UI;

Card 2 - Week Zero: provided information about PFMT, with proprioception and muscular contraction exercises, as well as information about the commands of the application, guiding the users on the best way to use it;

Card 3 - Exercise Program: presented a twelve-week PFMT program.

Card 4 - Healthy Behavior: encouraged the women to prevent or relieve constipation.

The information cards were intended to reinforce the information provided during the consultation and to encourage the patient to continue the learning process even when away from professional supervision.

In the **abstract interface** stage (phase 1c), the appearance of the system, as well as the combination of colors and images were defined with the help of a designer and a systems programmer hired for this purpose. Next, the application was transformed (**implementation** phase 1d) into computer language for use on smartphones and tablets using the JAVA language for the Android platform and the Swift language for iOS (Fig. 1). The database used to save user's data and progress in the training program was Firebase. For its installation, it needs to be downloaded from the Play Store or Apple Store.

The Continence App also has the following features: reminders to carry out the exercises that are programmable according to the user's wishes; visual and sound animation with timing of contraction and relaxation times for proper performance of the exercises (Fig. 2g–i), and the ability to monitor the PFMT progress. Therefore, the professional can use these resources to prevent the patient forgetting important data of her treatment.

Continence App validation (stage 2)

Validation by health experts

A total of 11 health experts, with a mean age of 34.5 (± 3.47) years and mean time since graduation of 13.5 (± 8.19) years, participated in the **content validation** (phase 2a). The majority were physiotherapists ($n=07$) and professionals with PhDs ($n=07$). All the participants fulfilled the criteria adopted for definition as experts. Regarding the CVI, 100% of the evaluated items obtained values of 0.90 or greater (Table 2).

The **appearance validation** (phase 2b) was also performed by the health area experts. The items referring to installation/use, aims, usability/interface and organization/presentation of the program received between 81.8% and 100% positive responses. Only the items "ways of submitting suggestions" and "provides positive reinforcement" did not obtain the minimum percentage

Table 1
Relationship between the constitutive definitions of the Health Belief Model (HBM) and the contents generated in the conceptual modeling of the application. Fortaleza-CE, Brazil, 2018.

Health Belief Model Components	Constitutive definition	Content generated
Perceived susceptibility	Belief that your health may be negatively affected by an event	Description of urinary incontinence risk factors in the puerperium
Perceived severity	The occurrence of the event will have negative physical and/or social consequences	Description of the urinary incontinence impact on puerperal women quality of life
Perceived benefits and decision-making	The performance of an action can minimize both your susceptibility and the severity	Description of the benefits derived from the adoption behavioral therapy and the training of pelvic floor muscles principles to prevent urinary incontinence in puerperium
Perceived barriers	Belief that the existing barriers to decision making and preventive action are outweighed by the benefits offered	Description of the time required to carry out the proposed preventive activities
Motivation to act	Consequence of the evaluation of the susceptibility, severity of the disease and the benefits deriving from the decision making	Motivation techniques for adherence to the proposed program
Self-efficacy	Ability of the individual to believe that they can successfully perform a given task	Organization of the application from an internal logic that is challenging, yet easy to master, with a graduated approach of the content (from the most basic to the most advanced)

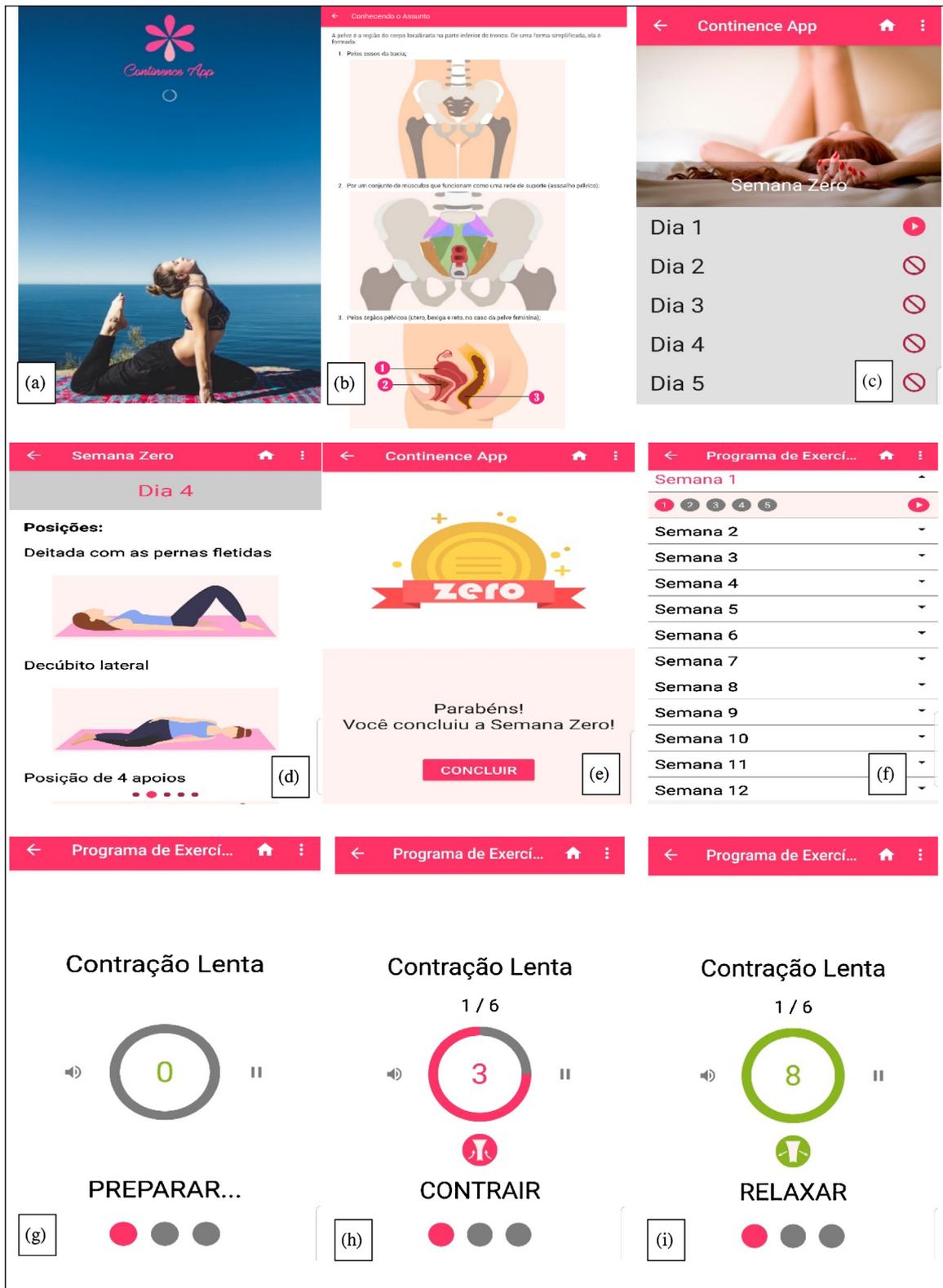


Fig. 2. Screen shots from Continecence App. Fortaleza-CE, Brazil, 2018.
 Legend: (a) Opening screen; (b) Card: knowing about the subject; (c) Card: zero week; (d) Card: Day 4 - Zero week; (e) Card: final screen of zero week; (f) Card: Exercises program – 12 weeks; (g,h,i) Cards: timer for help to do pelvic floor exercises (prepare, contract and relax).

required, since 33.3% of the evaluators did not identify the icons related to these functions in the application. The majority of the health experts (66.7%) considered that the application did not offer adequate positive reinforcement (Table 3).

Validation by information technology, computing and communication experts

The **appearance validation** (phase 2b) included 11 experts from the information technology/computing/communication

Table 2

Content Validation Indexes (CVI) of the Continence App according to the items evaluated by the experts on the subject - health area. Fortaleza-CE, Brazil, 2018.

Questions	CVI
CONTENT	0,96 [*]
Uses correct conventions and definitions	1,00
Correct concepts	0,91
Concepts understandable by the target audience	1,00
Concepts worked on are related to other concepts of the area	0,90
Works on the concepts in a graduated way	1,00

^{*} Global CVI of questions referring to the content.

Table 3

Percentage of positive responses of the items evaluated by the experts of the health area and of the information technology/computation/communication areas. Fortaleza-CE, Brazil, 2018.

Questions	Questions	
	Installation/use	
	AsHP ^a	
	AsIT ^b	
	(%)	
Easy to install	90,9	90,9
Functions are enough to achieve objective	83,3	90,9
Functions perform as they should	100,0	90,9
Free of bugs	100,0	90,9
Restart sessions	100,0	58,3
Objectives		
Clear objectives	83,3	100,0
Provides resources that justify its use	100,0	90,9
Arouses interest	100,0	83,3
Previously viewed content reviewed or reinforced	90,9	100,0
Learning of new content	90,9	81,8
Usability- Interface		
Interface suitable for the target audience	91,7	75,0
Functions easily understood	100,0	83,3
Functions easily used	100,0	100,0
Amount of information on each screen	91,7	75,0
Free from language errors	91,7	91,7
Easily understood messages	91,7	91,7
Has an alert for impossible actions	100,0	90,9
Action response time is adequate	100,0	100,0
Pleasant media	81,8	75,0
Allows the sound to be muted	100,0	91,7
Colors used in balance	100,0	91,7
Standardized language	91,7	100,0
Practicality		
Ways of making suggestions	33,3	50,0
Software		
User interaction	75,0	50,0
Has challenging logic	81,8	75,0
Is playful	91,7	90,0
Consistently explores the content	83,3	91,7
Encourages questions	83,3	70,0
Provides positive reinforcement	66,7	70,0
Has clear statements	91,7	100,0

^a AsHP – Assessment by Health Professionals.

^b AsIT: Assessment by Information technology/computing/communication professionals.

areas. Their mean age was 34.2 (± 4.53) years, with a mean time since graduation of 11.3 (± 5.79) years. The majority were male (81.8%) and from the information technology area (63.6%). With the exception of “restart sessions”, “ways of presenting suggestions”, “user interaction”, “doubts” and “provides positive reinforcement”, all the other aspects received between 75.0% and 100% positive responses (Table 3).

Suggested changes

The modifications to the Continence App suggested by the health experts were the inclusion of information regarding the

effect of the training on the pelvic floor muscles, adaptations to the proposed training program and encouragement to seek a specialized professional whenever the woman finds difficulty in performing the training.

The modifications suggested by experts in the areas of information technology/computing/communication were the creation of a navigation manual in the application with instructions about the content and icons available for access to facilitate navigation within the application; to link the application to the user's email account; to increase the font size used in some texts; to use fewer screens to carry out the tasks and to include an independent easy access menu.

Some suggestions for improvements regarding the item “user interaction” could not be implemented because they were not included in the initial budget of the funded project and because they would require a mobile device with more advanced specifications, which would restrict women's access to the application.

Validation by puerperal women

A total of 22 puerperal women participated in the appearance validation. Their mean age was 27 (± 5.42) years; the majority (86.4%) were married/in a stable union, housewives (59.1%), with a mean of 12 (± 2.85) years of study. All items evaluated by them obtained a minimum of 94.3% positive responses. Despite these good results, they suggested dividing the content of the information card “knowing the subject” into pages so that short excerpts of the text were presented on each screen of the application; replacing the image representing aging; changing the color of some application icons and adding a caption to the figure representing the voiding cycle.

Comment

The inclusion of digital technologies in the educational environment has contributed significantly to the teaching-learning process [25]. In the health area, various professionals have begun to use them as tools for health promotion and self-care, translating and disseminating the technical-scientific knowledge in an easy and accessible language [26]. In this sense, many applications have been developed to aid in self-diagnosis, as reminders to take medications and to promote healthy habits such as regular water intake and stimulation of physical activity [13]. However, most investments directed toward the development of health applications focus on specific themes such as Diabetes Mellitus and Mental Health [13], which corroborates the importance of the development of the Continence App.

To develop health applications it is recommended that they are based on secure theoretical and methodological frameworks [27]. Therefore, the review of the literature stage stands out as an important step, considering the need to deepen the investigation of the subject addressed, aiming to guarantee up-to-date and reliable information [23]. The content that composes the other behavioral approaches of the Continence App was also based on the recommendations of the International Urogynecological Association (IUGA) and International Continence Society (ICS), as well as other relevant publications in the area [28–31]. Accordingly, the teaching of PFMT by a trained provider, mediated by the use of the Continence App, may reduce adherence barriers and facilitate the performance of muscle training.

Another essential aspect is their evaluation process. For this, it is necessary to select professionals capable of contributing to the improvement of the technology constructed. In order to comply with these recommendations, in the present study professionals from different areas and with different academic and practical characteristics were invited to evaluate the constructed material.

The evaluation of the educational material by the target audience is also necessary, since it is at this stage that the researcher can see how the target audience understands and interprets what has been presented in the material and can observe the differences between what was constructed and what is expected by the consumer [11,32]. In this sense, the validation stage of the educational material aims to improve it and adapt it according to the suggestions of the experts and the target audience.

The Continenca App has been validated for use in the clinical practice as an educational technology in Portuguese to promote adherence to PFMT and prevention of UI in postpartum women, however, it can also be used during pregnancy and after the birth. The performance of randomized control trials is suggested, aiming to test the effectiveness of the Continenca App for UI prevention and to promote adequate knowledge on the subject. It is also important to evaluate the acceptability and adherence to the exercise program provided by this technology.

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