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SYSTEMATIC REVIEW

Mobile health technologies for the management of urinary incontinence: A systematic review of online stores in Brazil

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Abstract
Background: Urinary incontinence (UI) is a serious condition for which often times insufficient non-surgical treatment options are provided or sought. Mobile health (mHealth) applications (apps) offer potential to assist with the self-management of UI.
Objective: To perform a systematic review of available mHealth apps for UI in Brazil.
Methods: A search for UI mHealth apps from the Google Play Store and AppStore in Brazil was performed by two independent reviewers on June 4 2020, and the quality of eligible mHealth apps was assessed using the Mobile App Rating Scale (MARS).
Results: Of the 1111 mHealth apps found, 12 were eligible for inclusion. Four offered exclusively exercise programs, six offered exercise and educational content, and two offered tools to track patient-reported symptoms. The included apps scored poorly on the MARS quality scale, with a mean ± standard deviation score of 2.7 ± 0.6 on a 0–5 scale. Most apps scored poorly based on credibility, user interface and experience, and engagement.
Conclusion: Although there is growing interest in the development of mHealth technologies to support patients with UI, currently available tools in Brazil are of poor quality and limited functionality. Effective collaboration between industry and research is needed to develop new user-centered mHealth apps that can empower patients with UI.

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Introduction

Urinary incontinence (UI) is a severe condition that presents a significant socioeconomic burden for individuals and society and affects twice as many women than men, with an estimated prevalence ranging between 25%–45% among women worldwide.[1–3] Individuals affected by the condition have a significant reduction in their quality of life, with many reporting impaired emotional and psychological well-being, reduced social interaction and physical activity, presence of sexual dysfunction, and increased risk of falls.[4–6] In Brazil, knowledge about pelvic floor dysfunction and its treatment is still low among women.[7] Though nearly a third of women live with UI, 32% of female respondents to a nationwide survey did not know for how long the symptoms had been present, 45.7% said they did not know of any treatment for the condition, and more than 60% never sought treatment at all.[8,9] A study by the Brazilian Association for Continence indicates that patients with UI spend 25–40% of their average monthly income (R$2116.84) for medications and urethral tubes.[10] There is an unmet need for novel approaches that can reduce the burden of UI in Brazil.

Treatment options for UI are based on the predominant type of incontinence (stress, urgency, or mixed urinary incontinence) and the associated symptoms, patient goals and expectations, potential adverse effects, and economic status.[11] First-line treatment strategies are non-surgical and mainly include pelvic floor muscle training, in addition to lifestyle changes, including weight loss and fluid intake strategies.[12–17] Despite supporting evidence, the uptake of non-surgical treatments like pelvic floor muscle training is low due to a lack of specialized providers in the Brazilian healthcare system, therefore increasing the overall burden of the condition.[12,17]

Contemporary technologies, such as mobile health (mHealth) applications (apps), offer potential to assist the self-management of UI.[18] Patients can be empowered with educational information, reminders, medication diaries, symptom trackers, and peer support to improve treatment adherence, outcomes, and to better perform home exercise programs.[15] However, questions about the benefits of mHealth technologies in managing UI still exists.[18–23] Therefore, there is significant interest from clinicians, researchers, and patients affected by the condition to determine the quality of current mHealth apps for UI.[20,22–25]

To guide clinicians and researchers in their decision-making, the current status of mHealth technologies for UI-namely, the availability, functionality, and overall quality of apps-must be comprehensively reviewed. To the best of our knowledge, there are no systematic reviews classifying available mHealth technologies for UI in Brazil. The aim of this study was to systematically assess the availability of Health apps for patients with UI in Brazilian online stores, and to evaluate the apps with respect to engagement, user interface, experience, and information quality. This information will guide the development of more robust patient-centered apps for UI and inform healthcare providers and patients on the quality of mobile technologies available in Brazil.

Methods

The focus of this review was mHealth apps for individuals with UI available in the Brazilian Google Play Store (Google Inc) and App Store (Apple Inc). The term ''mHealth technology'' was defined as the use of technology for health purposes deployed in a mobile phone, smartphone, or tablet. Recommendations proposed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement and the Cochrane Collaboration for systematic reviews were used throughout the course of the study.[26,27] There was no ethical approval required for this study, as no personal data were collected.

Devices and search strategy

We searched for mHealth apps in Brazil at the Google Play Store (Android) and the AppStore (iOS) using one Android device (Google Pixel 4 XL, system version: Android 10) and one Apple device (iPhone 11 Pro Max, system version: iOS 13.4.1) on June 4, 2020. Together, the two stores account for 98.7% of the worldwide mobile phone market and offer more than 5.5 million apps to the public to download.[28,29] Search terms used were the same for both stores and were designed to search for apps related to UI management. The following keywords frequently searched in UI systematic reviews were used: ''urinary incontinence'', ''pelvic floor'', ''overactive bladder'', ''stress incontinence'', ''urgency incontinence'', and ''prostatectomy''.[30–33]

Inclusion and exclusion criteria

We only included apps that were a self-contained product (i.e., did not require add-ons or another type of external device to work). Also, because updates ensure software functionality and ongoing technical support to the users, only mobile apps that were developed or updated in 2018–2020 were included.[34] We included only smartphone apps in Portuguese (Brazil) language targeted to UI that provided information on at least one of the following recommended strategies for UI management: education, counseling, pelvic floor muscle training, or monitoring of patients' health. Apps that only provided advertising for a specific clinic or products were excluded. We did not limit our search by the development country of the app (i.e., apps could be developed outside Brazil), user age, or app costs, because we aimed to maximize the inclusion of mHealth apps.

Screening

Two independent reviewers (LD and CC) screened the mHealth apps. Unclear app descriptions were discussed between LD and CC to determine inclusion. A third reviewer (PD) was available to adjudicate any disagreements. When identical apps were available on both platforms (iOS or Android), the iOS version of the app was selected. When both paid and free versions of an app were available, only the paid version was reviewed. All additional paid functionali-

Table 1 Detailed Mobile App Rating Scale (MARS) sections.

Section	Characteristics
Engagement	Entertainment, interest, customization, interactivity, and fit to target group
Functionality	Performance, ease of use, navigation, and gestural design
Aesthetics	Layout, graphics, and visual appeal
Information	Accuracy of app description, goals, quality of information, quantity of information, visual information, credibility, and evidence base
Subjective app quality scores	Recommendation to other individuals, app star ratings, usage, and if users are willing to pay or not for the product

ties (in-app purchases) that were offered in free apps were purchased, and the full content of the app was evaluated. A final list of the included apps was created in an Excel spreadsheet (Microsoft Corp), with metadata about each app extracted from the stores. Relevant metadata included information about the developer, app price, app size (in megabytes), app version, a summary of the app contents, installation number, and content ratings.

mHealth apps quality assessment

To ensure full performance while evaluating the apps, both mobile phones used to search and assess the apps for quality were updated to the latest stable system version available. To assess app quality, we used the 23-item Mobile App Rating Scale (MARS).[35] This is a validated tool that assesses five app characteristics (sections): *engagement* (5 items), *functionality* (4 items), *aesthetics* (3 items), *information quality* (7 items), and *subjective app quality scores* (4 items). A detailed description of each section of the MARS scale is presented in Table 1. Each of the 23 items is scored using a 5-point scale, with higher scores indicating better quality. An overall mean ± standard deviation (SD) app quality score was calculated from individual mean scores of engagement, functionality, aesthetics, and information quality sections. Because MARS *subjective app quality scores* section is optional, it was not included in our analysis to strengthen the scale's capability to objectively measure app quality.[35] To answer MARS section D, item 19 ''*Evidence base: Has the app been trialed/tested; must be verified by evidence (in published scientific literature)?*'' we searched Google Scholar and Medline/PubMed, from their inception through June 2020, using the name of the app as a keyword. Online user ratings in app stores were not considered in evaluating the apps, as these can be falsified and may be invalid indicators of app quality.[36]

The two primary reviewers (LD and CC) were trained to use the MARS scale by studying training slides provided by the authors of the tool.[35] The meaning of any MARS items that could be potentially ambiguous was clarified between reviewers. A pilot test, for further training and to evaluate consensus between reviewers, was performed.[34] Ten randomly selected apps within the ''health & fitness'' and ''medical'' categories of the iOS AppStore were independently selected and assessed using MARS scale by the two reviewers, and their scores were compared. Any instances of disagreement (greater than 2 points difference in any of the MARS subscale mean scores) were discussed with a third reviewer (PD).[35] Health & fitness and medical apps were selected instead of specific UI apps to avoid recall bias of potentially included apps on this review by the two primary reviewers.

Results

Of the 1111 relevant mHealth apps found by our search, only 12 were eligible for inclusion (Fig. 1). Two apps (Floor App and UrinApp), were not found through our search, but were evaluated for inclusion in the study based on the authors' knowledge that its content was of relevance to individuals with UI. Ultimately, Floor App was excluded because it did not meet the inclusion criteria (not updated in the last two years). A total of 12 mHealth apps were included in the final review. Most commonly, apps were excluded because they were duplicates, not updated, or not relevant to the topic of this review. Of the 12 included apps, two (16.7%) were found in the App Store exclusively, six (50%) were found in the Google Play Store exclusively, and four (33.3%) were found in both App Store and Google Play Store. There were only two (16.7%) paid apps, ranging in price from R$7.90 to R$18.90. Five apps offered in-app purchases ranging from R$2.99 to R$29.90 each. The characteristics of the included mHealth apps are described in Table 2.

Of the 12 included apps, four offered exclusively exercise programs, in which users can access home-based exercise programs passively, through interactive videos or images with descriptions, or actively, by manually creating their own exercise programs. Six offered exercise and educational content about UI and its associated symptoms, pelvic floor anatomy, function, and training in addition to exercise programs. Two apps offered tools to track patient outcomes related to UI, such as daily fluid intake, frequency of urination, and frequency of pad changes. None of the 12 apps were tested as an intervention or part of an intervention in a randomized controlled clinical trial (RCT).

MARS scale

The mean ± SD MARS app quality score for the 12 evaluated apps was 2.6 ± 0.5 on a 0–5 scale. Most apps scored poorly for credibility, user interface, and engagement. The mean MARS engagement subscale score was 2.5 ± 0.7; the mean MARS functionality subscale score was 3.6 ± 0.4, with most apps being functional and easy to use; and the mean MARS aesthetics subscale score was 2.4 ± 0.8, with apps generally presenting unattractive layouts with low-resolution graphics. The majority of the apps provided low-quality

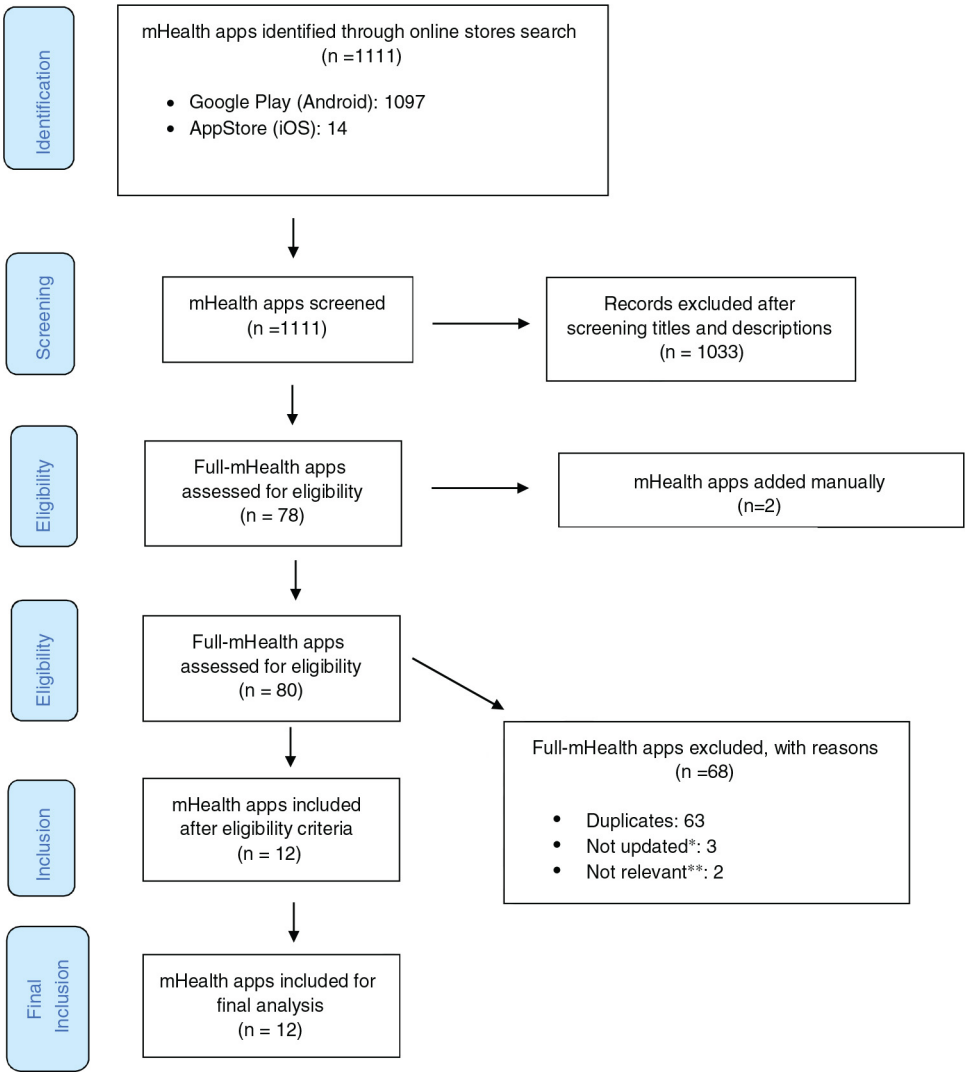

Figure 1 Flow diagram for mobile health applications (mHealth apps) search results.
Legend: *To ensure software functionality and ongoing technical support to users, only apps developed or updated in 2018–2020 were included. **One app only worked with the purchase of an external device (hardware), and the second app did not meet the language inclusion criteria after installation.

information from questionable sources (i.e. sources were not cited, or their legitimacy was unknown or unverifiable) and received a mean MARS information subscale score of 2.0 ± 0.8. There was high agreement between the two reviewers using the MARS scale, and differences between the scores never exceeded the 2-point threshold established for consensus. Table 3 presents the quality assessment of the reviewed apps using the MARS.

Highest scoring apps for UI

The three highest-scoring apps for UI had overall mean app quality scores ranging from 2.9 to 3.8. None of the apps provided social media components or interactive support groups for users. Of the top three apps, only ''Exercícios de Kegel-suelo pélvico, Treinador'' was customizable and presented a good level of content with an excellent visual appeal. However, none of them offered resources for patients to modify the training settings (frequency, series, number of repetitions, and contraction time), options to connect directly with a physical therapist, or the possibility to provide feedback to patients by analyzing the data collected. From the top three apps, only Continence App was developed by a research group (Universidade Federal do Ceará, Brazil).

Exercícios de Kegel-suelo pélvico, Treinador (overall mean app quality score 3.8)

This is a free app, with in-app purchases, available for Google Play platform only. The app provides users with a daily pelvic floor muscle training program, with a recommended training frequency of three times per day. Users can choose between the female and male profiles. The exercises are progressive and graded by levels (10 levels in total), and the total time to complete each level can vary from five to seven days. The app interactively displays the percentage of the level that has already been completed. The exercise

Table 2 Description of the Included Mobile Health Applications for Urinary Incontinence.

App name	Purpose	Platform	Price (R$)	Downloads*	Developer	Affiliations
Exercicios de Kegel	Exercise program	iOS	18.90	–	SUN TEAME PTE. LTD.	Commercial
Xiib-Exercicios de Kegel	Exercise program	iOS	Free**,[a]	–	Juan Garcia Montenegro	Commercial
Treinador Kegel	Exercise program and education	iOS and Android	Free**,[b]	1,000,000+	Olson Applications Limited	Commercial
Assoalho Pelvico-Exercícios	Exercise program	iOS and Android	iOS: 7.90 Android: Free**,[c]	10,000+	Stefan Roobol	Commercial
Continence App	Exercise program and education	iOS and Android	Free	5000+	Camila Vasconcelos	Non-profit
iPelvis	Exercise program and education	iOS and Android	Free**,[d]	1000+	iPelvis	Commercial
Exercícios de Kegel-suelo pélvico, Treinador*	Exercise program and education	Android	Free**,[e]	100,000+	Leap Fitness Group	Commercial
Diario Miccional*	Symptom Tracker	Android	Free	10,000+	Gustavo Avila	Commercial
Períneo Power*	Exercise program and education	Android	Free	5000+	Períneo Power	Commercial
Contração Perineal*	Exercise program	Android	Free	500+	KAZI Honda	Commercial
PhysioPelvic*	Exercise program and education	Android	Free	100+	Telma Pires	Commercial
UrinApp*	Symptom Tracker	Android	Free	5+	JVFE	Commercial

* Google Play store (Android) only.
** Contains in-app purchases.
[a] The app with all the in-app purchases costs R$ 10.90 (iOS).
[b] The app with all the in-app purchases costs R$ 22.90 (iOS) and R$ 19.99 for Android.
[c] The app with all the in-app purchases costs R$ 8.99 (Android).
[d] The app with all the in-app purchases costs R$ 29.90 (iOS).
[e] The app with all the in-app purchases costs R$ 12.99 (iOS and Android).

Table 3 Mobile App Rating Scale (MARS) scores of apps assessed.

App name	Version	*MARS* *Engagement*	*MARS* *Functionality*	*MARS* *Aesthetics*	*MARS* *Information*	*Overall app quality score*
Exercícios de Kegel-suelo pélvico, Treinador	1.0.0.4[b]	3.7	4.3	4.5	2.9	3.8 ± 0.7
Continence App	1.3[a]	3.3	4.0	2.8	2.9	3.3 ± 0.5
Treinador Kegel	7.4.0[a]	2.7	3.8	3.2	2.1	2.9 ± 0.7
Períneo Power	1.0[b]	3.0	3.5	2.0	2.9	2.8 ± 0.6
iPelvis	2.1.2[a]	3.0	3.5	2.2	2.6	2.8 ± 0.6
PhysioPelvic	1.0[b]	2.4	3.6	2.2	2.4	2.7 ± 0.7
Xiib-Exercicios de Kegel	2.2[a]	1.9	3.9	2.8	1.6	2.6 ± 1.0
Diario Miccional	1.1.2[b]	2.4	3.4	2.3	1.6	2.4 ± 0.7
Exercicios de Kegel	1.1[a]	1.7	3.6	1.8	1.8	2.3 ± 0.9
Assoalho Pelvico-Exercícios	2.1[a]	2.7	3.0	2.0	1.0	2.2 ± 0.9
Contração Perineal	1.08[b]	1.8	3.1	1.8	1.4	2.0 ± 0.8
UrinApp	1.2[b]	1.8	3.6	1.7	0.6	1.9 ± 1.2
Scores for all apps	–	2.5 ± 0.7	3.6 ± 0.4	2.4 ± 0.8	2.0 ± 0.8	2.6 ± 0.5

Data are means and means ± standard deviations. **MARS**: Mobile App Rating Scale. Score ranges from 0 to 5, where a score of 0 means inadequate quality and a score of 5 means excellent quality. The total score is based on the average of each subscale.
[a] Version at App Store (iOS).
[b] Version at Google Play (Android).

programs consisted of both fast and slow contractions of the pelvic floor muscles. To complete a series of each exercise, users alternate between contraction and relaxation repetitions, with a rest interval after the completion of each series that can be set according to the user's needs. As the user progresses, there is an increase in the total time to perform exercises at each level, as well as an increase in the number of repetitions and in the sustained contraction time. It is not necessary to finish one level to advance to another, which results in a better user experience for advanced users who download the app.

Continence App (overall mean app quality score 3.3)
This is a free app available for both iOS and Google Play platforms. This app is targeted to prevent UI in women after childbirth. The app contains information about the female anatomical features pertinent to UI, factors that can contribute to the onset of UI, description of the main UI types, lifestyle habits that can influence UI, and a pelvic floor muscle training exercise program. Before the training session starts, the user receives an educational session about the pelvic floor muscles, how to create/increase awareness of this region (e.g., palpation methods), and how to perform effective contractions. The exercise programs consist of both fast and slow contractions of the pelvic floor muscles. To complete a series of each exercise, users alternate between contraction and relaxation repetitions. There is a predefined rest interval after the completion of each series that cannot be adjusted to the user's needs. Exercise positioning is visually demonstrated using images. The app also has a reminder feature, so users can better plan their exercise. Unfortunately, there are no options for users to select the start level of the exercise program. To progress to the next level, the user must complete the previous level. This lack of customization makes usability difficult for advanced users that have had previous pelvic floor muscle training and do not intend to restart with basic exercises.

Treinador Kegel (overall mean app quality score 2.9)
This is a free app, with in-app purchases, available for both iOS and Google Play platforms. The exercises are graded by progressive levels, with each level consisting of 10 workout routines and different exercise programs. It is not necessary to finish one level to advance to the next, which allows for a better user experience. The exercise programs consist of both fast and slow contractions of the pelvic floor muscles, and to complete a series of each exercise, users alternate between contraction and rest periods. There is no relaxation period on this app after each exercise repetition. The app allows users to set goals, create reminders, and save the training progress. There is a tab within the app displaying a calendar where the user can check if the training sessions were completed. The ''How to use'' icon leads the user to educational content, including a brief explanation of the location of the pelvic floor muscles, coaching for contraction of the musculature by focusing on the pelvic floor muscles instead of using the accessory musculature, and suggestions for performing the workout routine two to three times per day. Users can create basic (control the time of sustained contraction, rest, and number of repetitions) or advanced customized sessions (create sessions with varying intervals time of contraction and rest; create multiple sessions of different durations). Additional features include the ability to activate the ''Ultra Discrete'' mode, which hides the name of the application and the ''contraction'' and ''rest'' commands from the cell phone display, allowing the user privacy to exercise anywhere.

Discussion

To the best of our knowledge, this is the first systematic review evaluating the use of mHealth technologies for UI available in Brazilian online app stores. Our study demonstrates that there is a significant unmet need for the development of new mHealth apps to better support individuals with UI in Brazil. The majority of the existing apps scored poorly on the MARS scale due to a lack of evidence-based information (i.e., whether the app has been scientifically tested or not), mediocre aesthetics, and subpar user interface (i.e., screen flow and visual elements) and/or experience (i.e., the internal experience that a user has as she/he interact with the elements of the app). This study corroborates the findings of a study evaluating the quality of pelvic floor muscle training smartphone apps in New Zealand (English apps only), in which 34 apps were included but were found lacking in their provision of evidence-based information and with respect to the quality of the user interface.[25] However, the mean MARS quality score (3.9 ± 0.4; range 2.9–4.4) for the apps in this previous study was higher than the one in the current study, indicating that English apps may be more attractive for individuals with UI perhaps due to a more effective collaboration between industry and research, more funding opportunities, or associated cultural factors.

The lack of evidence-based scientific information provided by the evaluated mHealth apps could be explained by the fact that most included apps (91.7%) were developed for commercial purposes, suggesting the need to promote better partnership between industry and academic institutions to develop healthcare apps. In addition to providing low-quality educational content, none of the assessed apps used validated patient-reported outcome measures to evaluate users' symptoms, limiting the reliability and external validity of the data collected. The use of validated tools, such as the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) and the King's Health Questionnaire, within an app environment, could have promising implications for research focused on UI.[37,38]

Currently, privacy and security aspects are not addressed by the MARS scoring scale. However, strict laws such as the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR) are already used to protect users regarding their health personal data in the United States and the European Union. In Brazil, data protection relies on the ''General Law of Data Protection''. In this review, more than 70% of the included apps did not present terms of use or privacy policies to users, and were thus non-compliant with data protection rules of Brazil, potentially posing risks to users' data security.

Although mHealth apps for individuals with UI are available in Brazil, the evidence for their effectiveness is limited. Of the apps included in our review, none were used as an intervention in a RCT; therefore, their efficacy in improving UI outcomes compared to other traditional treatments used in the clinical setting is unknown. Clinical trials performed outside Brazil have demonstrated potential benefits of using mobile technologies in terms of improvements in UI, satisfaction, adherence, and costs.[19] Only one RCT has been conducted in Brazil, and the results suggested that the use of an mHealth app increased the adherence to pelvic floor muscle training in women with UI symptoms when compared to written instructions only. The app used was ''Diário Saúde'', developed exclusively by the authors' research group in partnership with Eldorado Research Institute.[39] Unfortunately, the app is not available at online app stores.

To promote sustained usage, it is critical that mHealth apps possess core characteristics to increase usability and improve health outcomes. These characteristics include the possibility of making *plans* or *orders* within the app, to save time by not having to interpret the steps required to achieve a desired health goal; *data sharing* capabilities, including the export of activities/adherence and progress (or setbacks) to share with their health care provider; *usability features*, in which the layout of an app is efficient, intuitive, and allows for easy input of information; and *cost*, where affordability is balanced with value for the customer, leading to a better experience and better outcomes.[40] In addition, gamification (e.g., as badges, dashboards, scores, goals, and challenges within the app) and educational resources are also essential features to create active patient participation in patient self-management [18,41–43]

Strengths of our study include its rigorous systematic approach that follows well-established reporting guidelines.[26,27] Investigators underwent structured training in the use of the MARS scale prior to initiation of the study and demonstrated strong agreement. However, due to a lack of direct patient input, we lacked insight into the utility of the reviewed apps for individuals living with this condition. Other limitations are related to app-specific findings that will date quickly if existing apps are revised or improved and if new apps become available at online app stores in Brazil.

Conclusion

The use of mHealth technologies for UI is still a relatively new and unexplored topic, with much potential for future investigation. Our results suggest that an ideal mHealth app for patients with UI should provide content that is grounded in scientific evidence, respect the laws of privacy and security of the country in which it is being offered, include symptom trackers, keep individual records for personalized health goals, and allow for collaboration between users and healthcare professionals to design tailored pelvic floor muscle training programs.[19,44] This study calls for the collaboration of an interdisciplinary team of researchers, clinical professionals, patients, and application developers to develop new user-centered mHealth apps that will empower individuals with UI.

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Conflict of interest

The authors declare no conflicts of interest.

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