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REVIEW ARTICLE

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An ideal e-health system for pelvic floor muscle training adherence: Systematic review

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Background: Nowadays, Pelvic Floor Muscle Training (PFMT) is a first line, level 1 evidence-based treatment for urinary incontinence (UI), but adherence to PFMT is often problematic. Today, there are several mobile applications (mApps) for PFMT, but many lack specific strategies for enhancing adherence.

Aims: To review available mApps for improvement of adherence to PFMT, and to introduce a new App so called iPelvis.

Methods: Review study all available mApps for PFMT and relevant literature regarding adherence by electronic search through the databases Pubmed, Embase, CINAHL, LILACS, PEDro, and Scielo. Based on these results, development of a mApp, called "iPelvis" for Apple™ and Android™ systems, implementing relevant strategies to improve adherence.

Results: Based on the current adherence literature we were able to identify 12 variables helping to create the optimal mApp for PFMT. None of the identified 61 mApps found for Android™ and 16 for Apple™ has all these 12 variables. iPelvis mApp and websites were constructed taking into consideration those 12 variables and its construct is now being subject to ongoing validation studies.

Conclusion: MApps for PFMT are an essential part of first-line, efficient interventions of UI and have potentials to improve adherence, in case these respect the principles of PFMT, motor learning and adherence to PFMT. iPelvis has been constructed respecting all essential variables related to adherence to PFMT and may enhance the effects of UI treatment.

KEYWORDS
adherence, internet, mobile phone application, pelvic floor dysfunction, pelvic floor muscle training, pelvic physiotherapy, urinary incontinence

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1 | INTRODUCTION

Urinary incontinence (UI) is a prevalent condition which negatively affects women, men, and children of all ages,[1,2] negatively impacts quality of life of individuals,[2] and health care systems in general.[3] Treatment for UI are drug therapy,[4] physiotherapy,[5] and surgery.[6]

Nowadays, surgery is reported to have high rates of improvement or cure,[6] but costs of surgical interventions for UI are high.[1] Considering UI prevalence and costs, UI surgery takes a great deal of time of surgical center's daily routine. That, added to the poor number of surgeons in the Brazilian public health care system, in contrast to the huge population,[7] explains the long waiting lists for surgery, especially in the public health care system.[8] Plus, urodynamic studies are often required for proper assessment, sometimes for conservative treatment and often for surgery,[9] generating another waiting list, now for urodynamics.

Since 2005, pelvic physiotherapy, especially pelvic floor muscle training (PFMT) has been considered first line treatment for stress UI.[5] With a proper patient selection and satisfying cure rate, pelvic physiotherapy may diminish the queue for surgery. The International Consultation on Incontinence has recommended PFMT as evidence-based first line treatment for UI[5] and advises to try PFMT before any drug treatment or surgery for most of the patients. Unfortunately, today this clinical practice is still not the case in many countries, also not in Brazil, where the number of specialized pelvic physiotherapists is still too low. It can be concluded that more pelvic physiotherapists and surgeons need to be trained to fill up this gap. But what about other options?

Nowadays, PFMT is an advanced multifactorial first-line treatment modality of pelvic physiotherapy for UI in women,[10] men,[11] adjuvant in children,[12] genital prolapse,[13] lower bowel dysfunction,[14] and it is promising for female sexual dysfunction,[15,16] erectile dysfunction[17,18] and premature ejaculation problems.[19,20] Adequate PFMT improves strength, timing, pre-contraction, endurance, coordination, relaxation, and automatic contraction of those muscles,[5] overall to create for all daily activities proper muscle activity. By surrounding the urethra, vagina, and rectum, PFM function has direct influence on urinary continence, fecal continence and sexual function.[21]

The choice for a PFMT protocol is based on evidence-based, structured functional assessment,[22] evaluating and analyzing the nature and severity of pelvic floor muscle dysfunction—such as weakness of muscle strength, lack of relaxation, endurance, explosive strength, coordination, timing, and/or automatic activity. This assessment provides the exact parameters, intensity and dose of PFMT.[23,24]

However, success of PFMT is broadly threatened by insufficient adherence to the required PFM exercise program. Although positive reports of short[25] and long term effects[26] for practically every kind of pelvic floor dysfunction,[27] there is still doubt especially related to the long-term effects.[26,28] A major reason seems to be that only 64% of patients adhere to PFMT in the short term, even worse, only 23% in the long term.[29] Adherence is maybe the key factor for maintenance of PFMT efficacy.[29] For sure, adherence is a major cornerstone of an adequate and effective PFMT program.[29,30]

Adherence can be defined as "the extent to wish a patient's behavior matches agreed recommendations/instructions from the prescriber; it is intended to be non-judgmental, a statement of fact, rather than to ascribe blame to the patient, prescriber, or treatment method."[31] Adherence is crucial during the supervised clinical phase of PFMT (short term), and during the home-maintenance phase after ending the physiotherapy sessions (long term).[30] Several strategies to increase adherence short term as well as long term have been reported,[32] whereas long term adherence is the more problematic.[29,33]

Adherence is associated with better education and information about the importance of the pelvic floor and PFM skills for UI cure, with patient's positive feelings regarding PFMT, and with individualized approach, matching age, gender, and ethnicity.[32] Prioritization and integration of PFMT into daily activities[32] have been strongly recommended.[33] Unfortunately, adherence still is a weak point in PFMT programs.

On the other hand, rapid advance of internet and telemedia empower interpersonal communication more and more. Social media is now a reality, reachable for virtually every citizen in the world, and in 2014 internet access by mobile phone just overtook fixed internet access.[34] For instance, nowadays some very popular social media applications for the mobile phone, connecting people in real time, are used by more than one billion users.[35] In fact, interconnection has been improved daily.

The development of increasing use of social media facilitates a new horizon for adherence science, since new devices can be developed utilizing the environment of internet and social media, allowing new ways of contact between patient and therapist. Surfing on the internet, today, dozens of applications "training" the pelvic floor muscles by smartphone are available for the general public. For instance, using the keyword "pelvic floor" a quick search in the Google Play Store™, an engine for download Android™ mobile applications, shows 45 free download applications and 16 charged,[36] while Apple Store™ returns 10 apps, nine of them charged.[37]

Based on our narrative review, so far, there is no literature about the use of those applications by the general population. However, Google Play Store™ keeps a record of the total number of downloads of each application. A quick search reveals that three of these applications had been downloaded

more than 100 000 times, 13 of them more than 10 000 times. Only 30 were downloaded less than 1000 times. The mean of downloads by application was nearly 7000, and the total count for all applications exceeds more than half a million downloads, which shows the population's huge interest in mobile phone applications for PFMT. However, no relevant literature related to concepts, methodology, effects, or use of PFMT applications were found.

In most cases, the applications use simple instructions protocols, showing the patient images and/or sounds representing the time to contract and relax the pelvic floor muscles. No real feedback is offered, since there is no physical link between the mobile phone and the patient's body: those applications work in the same way as simple verbal instructions. Moreover, 33% do not specifically train the pelvic floor muscles but are a mix of PFMT with other general gymnastics.

Almost all relevant e-health systems lack evidence related to protocol, content, and procedures are not based on physiological training principles.[5] For instance, many applications did not use MAXIMAL PFM contractions during strength training. Others present endurance training using maximal contractions, violating solid principles of exercise physiology[38] and the IUGA/ICS validated protocol for PFM endurance training.[5,39]

Another issue is the lack of specificity: Often protocols are similar for all patients. Men or women, elderly or young, pregnant, mother or nulliparous: everyone will perform the same training program while each patient population requires different needs of PFMT.[5,39] Only two applications take notice of a referral by a health care professional, but literature shows that one third of women is unable to contract the pelvic floor muscle,[40] with often pushing down instead of lifting inward the PFM during the contraction.

Considering this whole panorama, a mobile application for PFMT could be useful as option for surgery and urodynamic exams, considering 80% of patients could be cured by physiotherapy.[5] But this application should be built respecting the modern and validated scheme of physiotherapeutic treatment, already proved to be efficient and effective.[5]

2 | AIMS

In this paper, the aim is to review current mobile applications (mApps) for PFMT adherence, introducing the concept of a new web-based platform for PFMT adherence. This one includes an especially designed website, use of social media, and specific designed mobile application for data collection and communication between the health care provider and the patient, aiming to establish long-term results, reinforcing adherence and motivation.

3 | METHODS

3.1 | Phases of methodological development

3.1.1 | Phase 1: face validity

What is needed for the optimal mApp for this population. By studying the literature and discussion (focusgroup) with experts related to this.

3.1.2 | Phase 2: content and face validity

Review of available mApps. Based on that, what should be includes into the optimal mApp and what should not.

3.1.3 | Phase 3: construct

To construct the new mApp taking into consideration content of the tool and working mechanism.

3.1.4 | Phase 4: feasibility and cost-efect

Testing the mApp in volunteers (feasibility study) and then in target group of patients (feasibility and then cost-effects).

3.1.5 | Phase 5: implementation

Implementation of results of former studies with iPelvis as mentioned before.

3.2 | State of art of mobile applications for PFMT

To identify and analyze the mobile applications today available for the public, an electronic search leaded by the terms “pelvic floor,” “perineum,” “pelvic,” and “incontinence” was performed on Apple Store™ and google Play Store™. Inclusion criteria were apps which contain exercises for UI or pelvic floor. Exclusion criteria were duplicated apps in the stores. Every app resulting from inclusion/exclusion was downloaded and installed respectively on a mobile Apple iPhone™ 6s or Samsung Galaxy™ s6 systems. Every app was then run, and variables relative to the construct were organized in tables by name, company, presence of micturition diary and/or validated questionnaires to assessment, type of exercise, presence of comic characters to mediate dialog, presence of levels of training, differentiation of groups of patients, need for a professional evaluation before to start the program, presence of daily tips to the health condition, types of stimulus for the training (verbal, image, sound, etc), daily reminders for adherence and need of vaginal probe. Those tables (Table 1 and Table 2) allowed straight comparison between the apps and the identification of lacks.

TABLE 1 Mobile applications for PFMT available on Google Play(TM) Store

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
Treinador kegel—exercicios	-	-	-	PFM	-	-	Women	-	-	-	Image	-	-
Pelvic floor first	-	-	-	PFM Assoc*	-	-	Women	Text	-	-	Image sound verbal	-	-
Prostate aerobics	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	-
Kegler	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	-
Innovo—restore the floor	-	Yes	-	PFM	-	-	Gender	Text	-	-	Image sound reminder	-	-
Bekkenbodem	-	-	-	PFM	-	Slow/fast contractions	Women	Text	-	Yes	Image sound	-	-
My PFF	-	-	-	PFM	-	-	Women	-	-	-	Image	-	-
TÄT	-	-	Yes	PFM	-	6 levels	Women	Text	-	-	Image	-	-
Bwom saude do assoalho pelvico	-	-	Yes	General	-	-	Women	Text	-	-	Image	-	-
Pelvic floor gym	-	-	-	PFM	-	Yes	Women	-	-	-	Image	-	-
Daily kegel workout: trainer	-	-	-	PFM	-	Begginer intermediate advanced extreme custom	Women	-	-	-	Image	-	-
Discreetly fit	-	-	-	PFM	-	-	Pregnants mothers menopause prevention	Text	-	-	-	Yes	-
Pericoach	-	-	-	PFM	-	Yes, in programs (beginner, intermediate, advanced, ongoing,	Women	Text	-	-	Image sound	-	Pressure

(Continues)

TABLE 1 (Continued)

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
						quick flex, free exercise) and levels (1,2,3 e test)							
Kegel coach	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	-
Exercicio kegel-treinador	-	-	-	General	-	-	Women	-	-	-	Image sound	-	-
Pregnacy pelvic floor plan	-	-	-	PFM	-	-	Women	Text	-	-	Text	-	-
Perda de urina, a incontinência urinaria	-	-	-	PFM	-	Yes	Women	Text	-	-	Image vibration	-	-
Women up (not yet released)	-	-	-	PFM	Yes	-	Women	Video	-	-	Image sound verbal	-	-
Pelvic muscle training-XFT0010	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	-	Pressure
Fit & firm	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	EMG
Ejercicios de kegel (vem com virus)	-	-	-	General	-	-	Men Women	Text	-	-	Image	-	-
Prostate aerobics	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	Yes	-
Airbee	-	-	-	PFM	-	Yes, have levels	Women	Text	-	-	Image sound	-	Pressure
Healthy bladder: diary & kegel	-	Yes	-	PFM	-	Yes, diferentes numeros de repetiçoes e segundos	Women	Text	-	Yes	-	Yes	-
Kegel	-	-	-	PFM	-	Yes, have	Women	Text	-	-	Sound	Yes	-

(Continues)

TABLE 1 (Continued)

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
aerobicsl						levels					image		
Birdi kegel trainer	-	-	-	PFM	Yes	Yes, have levels	Women	Text	Yes	-	Sound image verbal	Yes	Pressure
Perda de urina, a incotinencia urinaria	-	-	-	PFM	-	Yes, iniciante, intermdiario e senior	Women	Text	-	Yes	Vibration image	-	-
Pregnancy exercise	-	-	-	General	-	-	Pregnancy	Text	-	-	-	-	-
Innovo-restore the floor	-	Yes	-	PFM	-	Yes, treinos de 5, 10, 15 min	Women	Text Video	-	-	Verbal image	Yes	-
Yoga for prostate	-	-	-	General	-	-	Man	Text	-	-	-	-	-
Embarazo dieta y ejercicios	-	-	-	General	-	-	Pregnacy	Text	-	-	-	-	-
Kegel mate	-	-	-	PFM	-	Yes, levels	Women	Text	-	-	Image sound verbal vibration	-	Pressure
Elvie	-	-	-	PFM	-	Yes, levels	Women	Text	-	-	Image sound	-	Pressure
Physiotec	-	-	-	General	-	-	Women	Text	-	-	Image	-	-
Pelvicfly	-	-	-	PFM	Yes	Yes, levels	Women	Text	Yes	Yes	Image sound	Yes	Pressure
Enna				PFM	-	Yes, nivels	Women	Text	-	-	Image sound	-	Pressure
Carin exercise	-	Yes	-	PFM	-	Yes, levels	Women	Text	-	-	Image sound	Yes	Pressure
Candy	-	-	-	PFM	-	Yes, levels	Women	Text			Image sound	-	-
Kgoal-Beta	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	Pressure
KEGELT	-	-	-	PFM	-	-	Women	-	-	-	Image	-	-
Tasl-art and science of	Yes	-	-	PFM	-	Yes	Women	-	-	-	Image sound	Yes	-

(Continues)

TABLE 1 (Continued)

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
love													
Kegel exercise diy	-	-	-	PFM	-	-	Women	Text-	-	-	-	-	-
Iball	-	-	Yes	PFM	Yes	Yes, levels	Women	Text	-		Image sound	-	Pressure
Healthy bladder: diary and kegel	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	Yes	-
Kegel master	-	-	-	PFM	Men women	-	Women	Text	-	-	Image	-	-
Magic kegel	Yes	-	-	PFM	Yes	Yes, entry, middle, high, master	Women	Text	-	-	Image sound verbal	Yes	Pressure
Prenatal yoga pilates kristin	-	-	-	General	-	-	Women	Text	-	-	Image sound	-	-
Vive!	Yes	-	-	PFM	-	-	Women	Text	-	-	Image sound vibration	-	-
Entrenador de ejercicios kegel	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	-	-
Squeezy: NHS pelciv floor app	-	-	-	PFM	-	Yes, quick, slow, repetitions	Women	Text	-	-	Image sound vibration	Yes	-
Sqeeze men: nhs pelvic floor	-	-	-	PFM	-	Yes, quick, slow, repetitions	Women	Text	-	-	Image sound vibration	Yes	-
Pelvic floor training	-	-	-	General	-	-	Women	Text	-	-	-	-	-
Pregnancy postnatal exercises**	-	-	-	General	-	-	Women	Text	-	-	Image	-	-
Entrenador kegel pro	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	-	-
Kniiip	-	-	-	PFM	-	-	Women	Text	-	-	Image sound	Yes	-

(Continues)

TABLE 1 (Continued)

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
											verbal		
Knibeøvelser-gravid	-	-	-	PFM	-	Yes, beginners, moderate, advanced	Women	Videos	-	-	Image sound verbal	Yes	-
Exercise for the perineum	Yes, basic progam, program to elasticise the perineum, program to tone your perineum and free program	-	-	PFM	-	Yes, change nuber repeition	Men women	Text	-	-	Image sound	-	-
Efterfødsel	-	-	-	PFM	-	Yes	Women	Videos	-	-	Image sound verbal	Yes	-
TK pregnancy-prenatal class-exercicios para gravidas	-	-	-	General	-	-	Women	Videos	-	-	Image sound verbal	-	-
Fit mit baby	-	-	-	-	-	-	Women	-	-	-	-	-	-
Brigitte fitness health yoga	-	-	-	-	-	-	Women	-	-	-	-	-	-

No PFM protocols: general information, anatomy, etc; general exercises not specific for pelvic floor muscle (Pilates, etc); simple schedule for PFMT (no protocols); one (1) has failed installation. PFM associated: general exercises, in which PFM contraction are sometimes required

TABLE 2 Mobile applications for PFMT available on Apple(TM) Store

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
Kegel-pelvic floor exercise trainer	-	-	-	PFM	-	Yes, quick and slow	Women	-	-	-	Image Sound	Yes	-
Pregnacy pelvic floor plan **	-	-	-	PFM	-	-	Women	Text	-	-	Text	-	-
Bwom-saude intima e exercicios so solo pelvico	Yes	-	Yes	PFM	-	Yes	Women	Video	-	-	Image sound verbal	-	-
Knibeøvelser-traen din baekkenbund**	-	-	-	PFM	-	Yes, beginners, moderate, advanced	Women	Videos	-	-	Image sound verbal	Yes	-
Efterfødsel **	-	-	-	PFM	-	Yes	Women	Videos	-	-	Image sound verbal	Yes	-
Mykegel-kegel exercises and pelvic floor trainer	-	-	-	PFM	-	Yes, levels	Women	Text	-	-	Image sound verbal vibration	Yes	-
Candy-the intelligent kegel exercise trainer	-	-	-	PFM	-	Yes, levels	Women	Text			Image sound	-	-
Kgoal	-	-	-	PFM	-	-	Women	-	-	-	Image sound	-	Pressure
Keleger	-	-	Yes	PFM	-	-	Women	Text	-	-	Image sound	-	Pressure
Pericoach**	-	-	-	PFM	-	Yes, in programs (beginner, intermediate, advanced, ongoing, quick flex, free exercise) and levels (1,2,3 e-test)	Women	Text	-	-	Image sound	-	Pressure
Maple	Yes	-	-	PFM	-	-	Women	Text	-	-	Image	-	Eletrostimulation
Stamina-longer	-	-	-	PFM	-	-	Men	Text	-	-	Image	-	-

(Continues)

TABLE 2 (Continued)

Name/ company	Differs conditions?	Micturition diary?	Questionnaires?	Type of exercise	Comic character?	Different levels of training	Differs patients?	Didatic medias	Asks for professional evaluation?	Daily tips?	Stimulus for training?	Daily reminds	Probe
lasting sex kegel trainer for men													
Kegeline-kegel timer	-	-	-	PFM	-	Yes, medium, high, low	-	Text	-	-	Image sound voice vibration	Yes	-
Saude da mulher do pavimento pelvico tips-proteger	-	-	-	PFM	-	-	Women	Text	-	-	Image sound verbal	-	-
Como proteger e restaurar seu guia do pavimento pé	-	-	-	PFM	-	-	Women	Text	-	-	Image sound verbal	-	-
Como proteger e restaurar a sua regiao pelvica: saude feminina	-	-	-	PFM	-	-	Women	Text	-	-	Sound verbal	-	-

No PFM protocols: general information, anatomy, etc; general exercises not specific for pelvic floor muscle (Pilates, etc); simple schedule for PFMT (no protocols); one (1) has failed installation. PFM associated: general exercises, in which PFM contraction are sometimes required

3.3 | Adherence theories and models

Nowadays, twelve theories or models related to behavioral changes and PFMT adherence Table 1 can be identified: health belief model, theory of planned behavior, social cognitive theory, trans-theoretical model, self-regulatory model, health action approach, information-motivation-behavioral skills, behavior change techniques, capability, opportunity and motivation behavior, normalization process theory, motivational interviewing and information, satisfaction, recall model.[29] The iPelvis system was constructed taking into consideration all these theories and models.

3.4 | Identification of relevant topics to be included for the construction of iPelvis

Electronic searches were performed to find out actual topics on adherence to pelvic floor muscle training. Six digital databases (Pubmed, Embase, CINAHL, LILACS, PEDro, and Scielo) were searched, through the keywords "adherence," "compliance," "communication," and "interaction," combined to "physiotherapy," "urinary incontinence," "prolapse," "sexual dysfunction," "pelvic floor muscle training," and "pelvic floor muscle exercise." Searches were limited to publications in English, Spanish, French, and Portuguese. Papers were sorted by relevance (first the paper where adherence was the main aim), and organized in tables by author, year, theme in adherence, health care provider specialty, paper's results, and recommendations. Issues were then sorted hierarchically according to importance and difficulty to implement, by themes, and translated into topics, over which the framework of the application was built.

3.5 | PFMT protocol

Considering the actual PFMT protocol[5] has today level one evidence and grade A recommendation, iPelvis was built on the base of Bø et al[5] PFMT protocol.[39]

4 | RESULTS

Phases 1-3 of methodological development are described in this paper. Phases 4-5 are being researched by clinical trials (ClinicalTrials.gov protocol ID # 66541417.5.0000.5221).

4.1 | State of art for mobile applications for pelvic floor muscle training

On Google Play Store™ 138 apps were available, from those 77 could not be included because they contained no PFMT protocol, most of all free for download (Figure 1). Only four apps differentiate health conditions (UI, sexual dysfunction, constipation, etc.), four contain some kind of micturition diaries, only three contains questionnaires for UI and only 26 of them have different levels of training. One differentiated the conditions (mother, pregnant, etc.), one between men and women and four between pregnant and non-pregnant. Most of the apps (43) used text as associated didactic media; only three of them contain videos. Two apps asked for a professional evaluation before to start of the program, and four had daily tips to adherence, while 16 had daily reminders for the exercises. Image and sound were the most frequently used command to the exercise (33), followed by verbal command (9), vibration (6), image only (3), and text (1). None of them contains comic characters. No app contains all those 13 variables (Table 1).

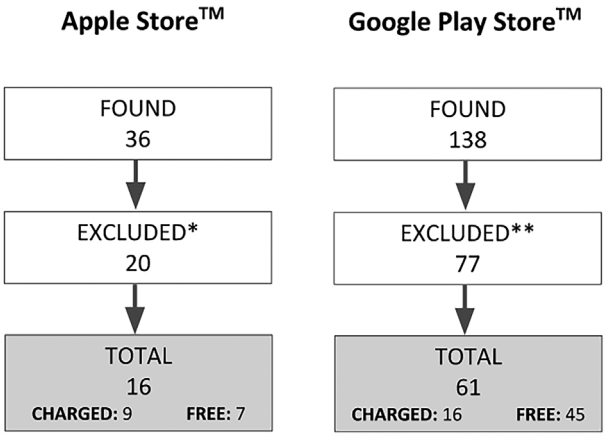

FIGURE 1 Flowchart showing inclusion and exclusion criteria for mApps

On Apple Store™ 36 apps were found, 20 of them not included. Two of them differentiated health conditions, two had questionnaires, all of them included PFMT, eight had different levels of PFMT, one was for men, and all others for women, three had videos as didactic media, all the others only text, none asked for professional allowance to start the program, none had comic characters, none had micturition diaries, image, sound, and verbal command to the exercises were found in four apps, vibration, voice, images, and sound in two, only images on two, and text in only one. Five of them had daily reminders for adherence. No apps had all 13 variables (Table 2).

4.2 | Framework of iPelvis

Based on the current literature,[29–33,41] we were able to identify 12 variables helping to create the ideal mobile application for PFMT. Those variables are (1) specification of relevant pelvic floor and bladder problems (for instance SUI, UUI, obstipation, sexual dysfunction, etc); (2) micturition diary; (3) specific validated questionnaires; (4) specificity of PFMT protocol; (5) training levels adjusted to patient's need; (6) a comic character stimulating a patient's positive attitude,

taking into consideration patient's age, condition, and ethnic group; (7) relevant and comprehensible education program as a first phase of the treatment, using multimedia tools; (8) promotion and release only by health professionals; (9) adequate and efficient behavioral therapy protocol (for instance advice regarding drinking pattern); (10) emphatic verbal and visual instructions for optimal use of (PFM) exercises; (11) an effective biofeedback protocol to instruct the patient to find and feel the PFM contraction and relaxation, especially during the early stages of PFMT; and (12) push notifications to remind the patient to train, and to encourage her to keep going. We find no references about the need or importance of vaginal probes for adherence.

So, iPelvis is a system anchored on a mobile phone application for adherence to PFMT for women with UI. The complete program consists of 104 different phases, taking into account type and severity of UI status for different patient populations. For each type, there are 15 phases during a 6-month training program, with each phase building on realization of objectives of the former one, favoring the contact between the patient and the related health professional, and respecting differences among individuals.

After downloading the application and registration in the iPelvis platform by her health professional, the patient will need an access code to start the program. This strategy is necessary because more than 30% of women cannot contract properly their PFM at the first physiotherapy session[23] and should improve first their capability of contracting the PFM under guidance of their pelvic physiotherapist.[5] So doing, the iPelvis protocol follows the PFMT motor learning principles.[24,39]

Before using iPelvis, first, the patient needs to sign an informed consent, stating that iPelvis may use, anonymously, generated data for scientific purposes. Next, based on indication of the health care professional, type of UI will automatically be set (stress, urgency, mixed).[42] For each type of incontinence there are four categories of patients: age 18-60 years, >60 years, pregnant and postpartum up to 6 months after delivery, each with a specifically designed evidence-based PFMT program, respecting differences in levels and intensity of PFMT between general or elderly women,[43,44] pregnant or women after 6-month postpartum[45] (Figure 2).

With patient category and type of incontinence defined, the patient is able to start the evidence-based 6 months PFMT program,[5] with 12 phases of 15 days each, with crescent level of difficulty, respecting physiological criteria of PFM motor learning.[24] Once a phase is completed, the patient digitally scores her progress between 0 and 10, with 10 most optimal progress. Saving the digital score in the database the next phase will be unlocked. In order to respect motor learning principles, it is not possible to skip any level.

4.3 | The "5F" program

IPelvis introduces the 5 "F" program of PFMT. The iPelvis "5F" program for PFMT is evidence based, level 1, grade A.[5,24] The 5Fs stand for (1) F = find, (2) F = feel, (3) F = force, (4) F = follow through, (5) F = functional training.[40] Each phase contains video materials, in which the iPelvis comic character guides the patient to contract and relax her PFM in a timely and coordinated way.

4.4 | Find the pelvic floor: the 1st F

The patient starts the iPelvis PFMT program with education about anatomy, physiology, biomechanics, pathophysiology, and the potential of physiotherapy[5,24] using video materials including didactic metaphors, images, and narrated animations, all moderated by the iPelvis comic character (Figure 3).

4.5 | Feel the pelvic floor: the 2nd F

Being able to find the PFM, now the patient will learn to execute selective contractions and relaxations of the PFM, first performing mono tasks, then double tasks, followed by multi tasks. Success is defined as the patient is able to feel

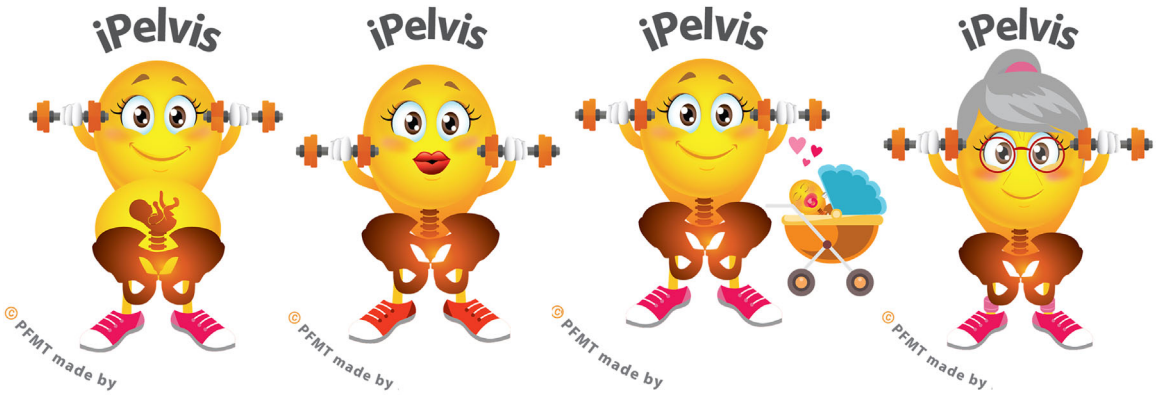

FIGURE 2 Individualized PFMT for pregnant, postpartum, general, or elderly women

FIGURE 3 Metaphoric house where the pelvic floor is presented as the foundation, supporting it all. The respiratory diaphragm is the roof, the bladder the front living room, the rectum the kitchen in the back, and the vagina the ladder between living and kitchen

selective PFM contractions and relaxation in different situations, positions, and activities. This phase is a prerequisite for the following strength- and coordination training (Figure 4A).

4.6 | Force the pelvic floor: the 3rd F

During the 3rd "F" training, strength, explosive strength, endurance, timing, pre-contraction, exhaustibility, coordination will be reinforced according to physiological rules and principles of motor learning and strength training.[5,24,39] Each subsequent phase of 15 days has a higher level of load/difficulty compared to the former one. Only by filling out the required questionnaire the next phase will be unlocked (Figure 4B).

4.7 | Follow through: the 4th F

In the 4th "F" phase the patient with (now restored) awareness how to contract and relax the PFM, builds up strong and fatigue resistant pelvic floor muscles. This strategy of aware contractions to prepare the PFM to act fully automatic and adequate during all kinds of (functional) activities with intra-abdominal pressure rise such as lifting a baby, playing tennis, sneezing, coughing. The follow through phase, or simple "the 4th F," is based on two fundaments: (1) to facilitate functional training and (2) to incorporate the training in daily life activities of the patient —which is the final aim for adherence.

4.8 | Functional training: the 5th F

The 5th "F" phase facilitates restoration of UI during real time daily life activities or by mimicking these situations using gaming and virtual reality. The program supports self-confidence and aims to restore feelings of well-being during fun-, favorite—of former activities because these activities are again possible without the fear for shame, uncertainty related to and embarrassment of involuntary urine loss. Description of the full program of 12 phases of 15 days each can be requested at the first author of this manuscript.

At the end of every phase the patient voluntary fills out validated questionnaires, so-called phase tracking questionnaires, related to the patient's subjective impression of severity and impact of UI such as the PRAFAB[24] and patient's opinion about learning level because of using the mobile

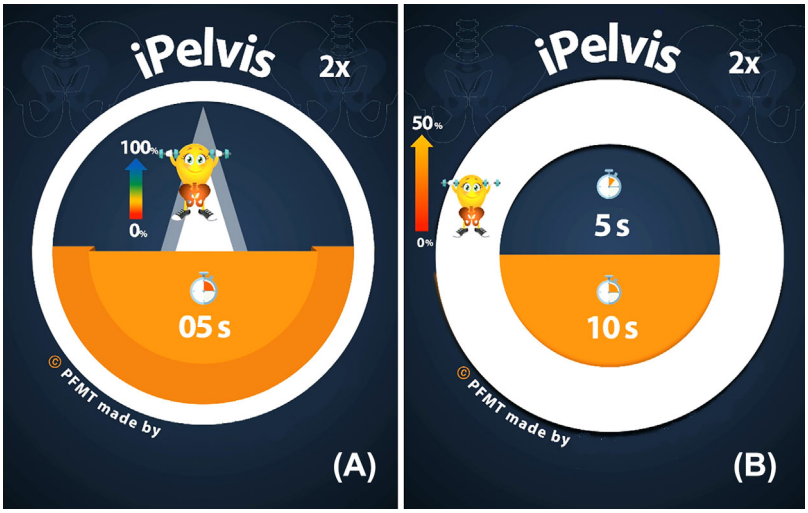

FIGURE 4 Video animation leading to simple contraction and relaxation of the pelvic floor muscle. A, fast contractions. B, slow contractions

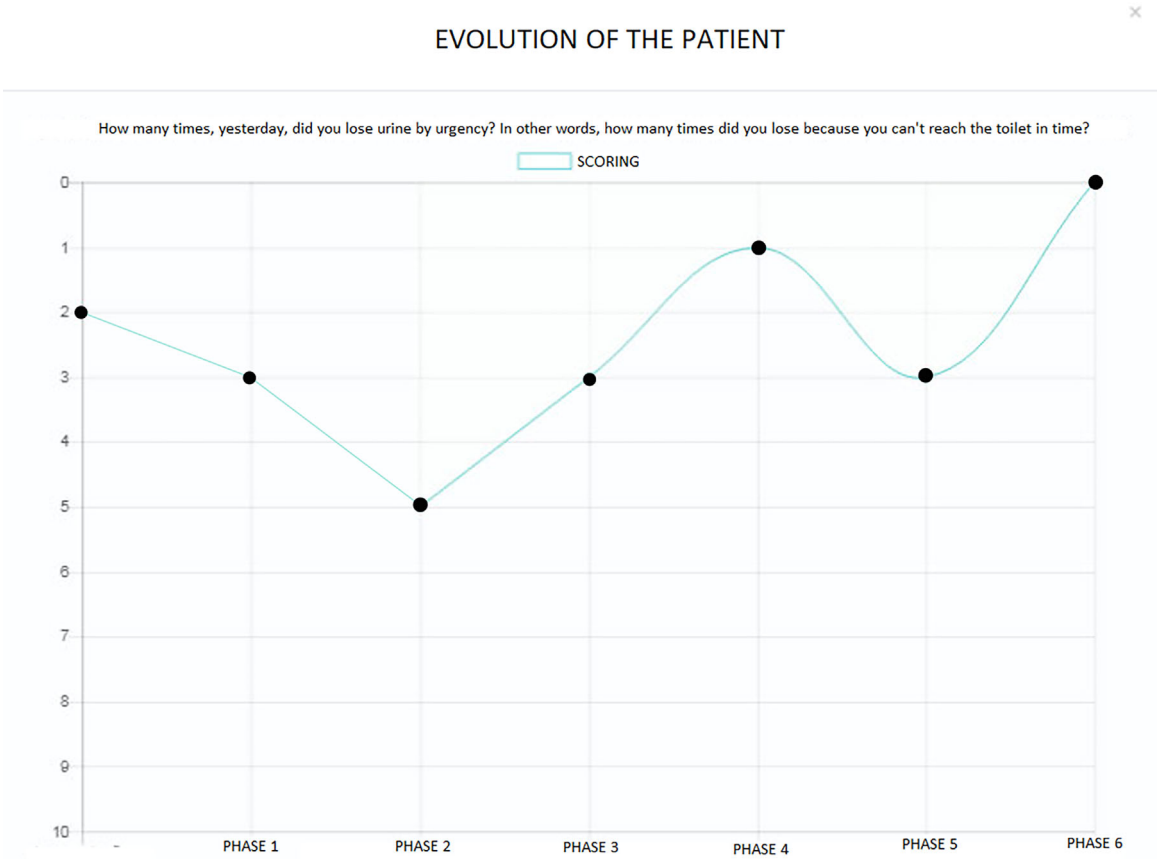

FIGURE 5 Graph plotting the progression of the patient, into the administrative area of ipelvis.com website

application. Acquired data are stored in the iPelvis system. Another questionnaire gathers quantitative information on patient's satisfaction using the tool.

4.9 | Controlling the training

The administrative area allows the health professional to follow up the patient's progression (Figure 4). In case the patient does not comply with the weekly physiotherapy sessions, the professional can block the use of the mobile application in order to avoid uncontrolled self-training.

The home maintenance PFMT program is supported by the mobile phone application interface. Timing and intensity of PFM contraction is shown graphically and by sound as is the PFM relaxation and rest time between contractions and series of exercises. One important component of the mobile App is the voice command, apparently determinant to adherence.[29] So, iPelvis contains voice commands, in a very emphatic way, taking into account the importance of an emphatic physiotherapist as adherence determinant.[29]

Whenever a patient ends a phase, completing the respective protocol, she is rewarded with (success) points, as in a videogame scoring. The comic character, "iPelvis," mediates all the system dialogs. In case of bad adherence, iPelvis as the character "gets weak" and "sad," begging the patient to perform the exercises properly.

An unprecedented innovation is that the iPelvis character is ethnically matched with the patient, in skin color, country flags and cultural costumes, to facilitate empathy. iPelvis is also matched by age and condition, for instance, being pregnant.

4.10 | Data storage

The therapist application databank stores data of (1) number of prescriptions of iPelvis; (2) how often the professional accesses the system; (3) which kind of exercises are mostly prescribed; (4) which iPelvis tools are used most frequently—for instance, comic cards posted in social media, exercise reminders for patients, etc; (5) which cards are posted more frequently; and (6) which videos are shared more frequently. In this way statistical information can be gathered about which elements were more often used, and which ones were left behind. This strategy helps to select successful elements and to skip unsuccessful ones. Simple frequency bar charts of the total number of accesses, sorted by period provide the iPelvis scientific staff continuous information of frequency of use or discontinuation of use of any particular element.

The patient application databank stores data every time the patient accesses the mobile application (Figure 5). Variables are (1) number of daily accesses; (2) start of use of exercise protocols, partially completed or completed; (3) number of hours, to complete a protocol; (4) goals achieved or not achieved; (5) exercises completed or aborted; (6) cards more frequently received; and (7) number of accesses of the patient chat area. Data will be used to improve the iPelvis system continuously, considering most frequently used tools by the patients. Special focus is on optimizing exercise protocols. All data are collected anonymous, using coding in such a way that identification of any individual is impossible.

4.11 | Daily advices

iPelvis contains many different pictures supporting the pelvic physiotherapy program. There are pictures about the PFMT, but also about sufficient drinking, fiber ingesting, weight control, etc. During the physiotherapy program, automatic messages can be send by the pelvic physiotherapists as push notifications, as reminders to drink, eat healthy, or train. iPelvis acts as a friendly guide/partner during the home-based PFM training, using biofeedback images and video materials. According to recent adherence evidence, iPelvis also contains inspiring pictures for social communication, such as anniversary or birth cards.[10]

Besides the communication between the patient and her own physiotherapist, iPelvis will constitute a selected digital (chatting) platform for women with similar health problems making possible to exchange experiences, ideas, news, questions, etc. Frequently asked questions are moderated and answered by an iPelvis health professional. It has been shown that patients with pelvic floor dysfunctions highly value this kind of mutual and professional support such as contact with co-sufferers who have similar health problems.[46]

iPelvis has also an educational, free access website (ipelvis.com) containing evidence-based material on pelvic floor dysfunctions, pelvic physiotherapy and related health conditions, understandable and accessible for the lay public.[5] The iPelvis website and facebook page enjoy already high popularity on Facebook™ which is considered today the world's biggest social network[47] especially in Brazil, the world leader on Facebook™ interaction,[48] actually the country where iPelvis was first released in 2017.

4.12 | Validity of iPelvis

To investigate its usefulness and validity, at the moment several clinical studies regarding face-validity, content validity, and construct validity of iPelvis are being executed. Publication of these data are expected later this year.

5 | DISCUSSION

The actual state of art of mobile applications for PFMT shows today there is no available application which incorporates an efficient and evidence-based home maintenance PFMT program. In the other hand, PFMT today has level one grade A evidence on pelvic floor muscle function recovery,[5] and there is some evidence guiding to parameters for better adherence on PFMT.[10,29–31,33]

There are six adherence modifiers based on cognitive, affective, and physical PFMT experiences for the patients: knowledge, physical skill, feelings about PFMT, cognitive analysis, planning and attention, prioritization, and service provision. It is recommended to inform patients to increase knowledge about the condition, to teach the physical skills of the pelvic floor muscles, promote positive feelings, and decrease negative feelings about PFMT, enable constructive analysis planning the attention to PFMT, prioritization of PFMT in patient's life.[41] iPelvis is also a comic character, to facilitate in an emphatic way decrease of shame and taboo surrounding UI, and to decrease negative feelings about resolving the problem. iPelvis starts with multimedia helping the patient to improve knowledge and insight in the health problem, the pelvic anatomy and the pelvic floor muscles functions. Physical skills of the patient are trained in a structured and didactic way. The modifiers of adherence are constantly stored in the iPelvis system's data bank.

Short-term determinants include positive intentions to adhere, self-efficacy expectations, attitudes towards, and perceived benefits of the exercises and high perception of social pressure to adhere. Long-term determinants include positive adherence intentions and self-efficacy expectations. Recorded audio messages improve the routine practice of home exercises.[29] Considering these data, iPelvis shows the patient's progress in an enthusiastic way, facilitates patient's quality of life, puts pressure on the patient to adhere and comply in an empathic way, and helps the patient to face the health problem UI, appealing to the patient's own responsibility to train. Audio messages are integrated in the whole application, including those that support the patient during the exercises: “Come on, contract! Hold! Hold! And relax! Well done!”

Based on appropriate behavior-change theories, clinicians must be made aware of the importance of behavioral changes in PFMT.[30] The iPelvis system, built on behavior-change theories, can serve the health professional to focus on the patient's behavior change, in an easy and ludic way for the patient, and a controlled and structured way for the professional in charge.

There is an urgent need of studies on PFMT adherence measurements and determinants.[10] PFMT adherence is complex and needs behavioral changes and active patient participation.[49] Plus, adherence must be systematically reported in all PFMT studies, both during and after supervised

interventions, to adhere to PFMT components (during clinical intervention period or home exercises) and all stages of treatment (intervention, post-treatment, and follow-up). Day-to-day integration of PFMT exercises is also crucial.[29] Considering these concepts, the administrative area of the iPelvis system allows anonymous data collection of adherence during a structured PFMT, and this data can lead researches to clarify determinants of short and long-term adherence. The iPelvis data bank is dynamic and real time, considering all instruments collecting data in adherence must measure outcome, must be dynamic and self-improving.[29] This dynamicity allows the whole system to improve itself easily, based on the observations of the iPelvis staff and minor changes on the algorithm or related devices.

So far, mobile applications for PFMT works better in who are interested in and have high expectations about it[50] but are a first-line cost-effective treatment with potential to increase the access to care.[51,52] Despite adherence in PFMT being describe in current literature, Tables 1 and 2 showed none of all 77 mApps available to download incorporate all the 12 parameters literature pointed out as fundamental for an ideal mApp for PFMT adherence. In the other hand, iPelvis combine all those 12 parameters in a single mApp.

6 | CONCLUSION

Lack of adherence is today a major drawback of PFMT success. Literature today shows guidance for improve adherence, and the increasing use of social media opens way for mobile applications helping to improve PFMT adherence. There are, today, dozens of PFMT mobile applications, but none having all the evidence-based parameters for correct PFMT.

Current evidence of adherence on PFMT together with PFMT evidence-based grade A level one protocol allowed the construction of a mobile application, so called iPelvis. As an ambitious newcomer in the field iPelvis system may contribute to fill up the gap. For sure much more must be done, but iPelvis seems to be an easy accessible an low cost concept (considering it is available for download in all mApp platforms and it is less expensive than surgery or physiotherapy itself) to improve efficiently adherence and compliance to PFMT. So far, mobile applications for PFMT works better in who are interested in and have high expectations about it but are a first-line cost-effective treatment with potential to increase the access to care.

6.1 | Recommendations for clinical practice

We recommend the use of evidence-based mobile applications for PFMT for improve adherence of pelvic physiotherapy and to improve the access to urinary incontinence care.

6.2 | Recommendations for research

Clinical trials on validity of the different aspects of mobile apps for PFMT are needed.

AUTHORS' CONTRIBUTION

GFSL Substantial contributions to conception and design; drafting and revising the article critically for important intellectual content; and final approval of the version to be published. RdeF contributed in final approval of the version to be published. MRS substantial contributions to conception and design and final approval of the version to be published. CVM contributed in final approval of the version to be published. BB substantial contributions to conception and design; drafting and revising the article critically for important intellectual content; and final approval of the version to be published.

CONFLICTS OF INTEREST

All the other authors declare that they have no conflicts of interest to disclose.

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