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SOFTWARE REVIEW

iPhone apps as an adjunct to supervised physiotherapy for pelvic floor muscle training in women: a content analysis

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Abstract
Pelvic floor muscle (PFM) training can be effective in the treatment of women with urinary incontinence (UI) and pelvic organ prolapse (POP). However, patient adherence to PFM training (PFMT) can be problematic, which may limit positive treatment outcomes. Therefore, methods that help to increase adherence to PFM exercises (PFMEs) are worthy of investigation. A novel approach is the use of smartphone applications (apps) that have been designed to promote PFMT. The aim of this paper is to compare and critically review Apple iPhone apps of this kind. A search on the UK Apple App Store was undertaken. Apps were included in the analysis if these: were compatible with the Apple iPhone; were in the English language; had a clear primary aim of teaching or promoting PFMEs; and cost £5.00 or less. Each eligible app was compared and evaluated against four key criteria: the provision of education; exercise reminders; exercise progressions; and the facility to record exercises. Twenty-three apps were included in the analysis: 11 gave accurate and detailed information and instruction; nine provided exercise reminders at frequencies recommended by key treatment guidelines; 12 offered progressive exercise levels; four allowed the recording of exercise; and three fulfilled all four key criteria. Some do appear to have a strong evidence base, and would be worthy of recommendation in clinical practice. Apps are potentially powerful tools in promoting adherence to PFMEs, and effective adjuncts to physiotherapy treatment in the management of female UI and POP.

Keywords: adherence, iPhone apps, pelvic floor muscle exercises.

Introduction
Urinary incontinence (UI) is a common condition that can adversely affect physical, social and emotional aspects of life. Current clinical guidelines recommend at least 3 months of pelvic floor muscle (PFM) exercises (PFMEs) as the first-line treatment for UI (NICE 2013). Recent research has also shown that PFMEs can help to reduce the symptoms of pelvic organ prolapse (POP) (Hagen *et al.* 2014). The benefits of PFMEs may take several months to achieve (Bø 1995); however, patient adherence to exercise programmes can be problematic (Hay-Smith *et al.* 2007; Whitford *et al.* 2007), which may limit positive treatment outcomes. Hence, a novel method to increase adherence to PFM training (PFMT) is worthy of investigation.

The use of modern technology, such as smartphones, is now commonplace within the developed world, and there were estimated to be 1.9 billion smartphone subscriptions globally at the end of 2013 (Ericsson 2013). The use of mobile applications (apps), which are small programmes or software that can be downloaded from the Internet to smartphones, is also increasing. It is reported that over 2 billion apps are downloaded

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every month from the Apple App Store (Apple 2013), many of which are related to health and fitness. For example, apps exist for smoking cessation, medication adherence and reducing the risk of developing diabetes. Apps are also available for the management of UI and POP. However, to date, no studies have compared or evaluated the quality of content of PFMT apps. Therefore, the aim of the present paper is to compare and critically review Apple iPhone apps that are designed to promote PFMT, and to evaluate whether it is worthwhile recommending apps as a treatment adjunct in the management of female UI and POP.

The authors describe the effects of female UI and POP on quality of life (QoL), the evidence behind PFMT, and the barriers to and facilitators of adherence to a training programme. Following this, the search strategy used to identify PFMT apps is explained, and the apps included are critically evaluated. Finally, recommendations for using PFMT apps as an adjunct to physiotherapy management are made.

Background

Urinary incontinence is defined as any involuntary loss of urine that may occur with sneezing, coughing and exertion [stress UI (SUI)], or in association with urgency [urge UI (UUI)]. Mixed UI (MUI) is a combination of SUI and UUI symptoms (Abrams *et al.* 2010). Approximately 32–42% of women dwelling in the community (Hunskaar *et al.* 2004; Buckley & Lapitan 2009) experience UI at any one time. Its effects are manifold and include: feelings of embarrassment and low self-esteem (Ashworth & Hagan 1993); and a negative impact on both QoL (Bartoli *et al.* 2010), and the ability to participate in social and sporting activities (Hayder & Schnepp 2010). Relationships and sexuality may also be affected (Hayder & Schnepp 2010; Siu & Lopez 2012). Additionally, a financial burden is not only placed on individuals, who may need to regularly purchase pads and other containment products, but also on the workforce since UI can lead to diminished work attendance and performance (Sinclair & Ramsay 2011).

A Cochrane systematic review (Dumoulin & Hay-Smith 2010) concluded that PFMT is effective in reducing UI. The analysis, which included 12 trials (involving a total of 672 women), found that women who participated in PFMT were more likely to achieve greater improvement, in terms of subjective reports of cure or improvement, decreased leakage, and better QoL, compared to those who did not. This systematic review supports current treatment guidelines, which recommend a minimum of 3 months of PFMT as the first-line treatment for SUI or MUI, and suggest that at least eight PFM contractions should be performed three times a day (NICE 2013).

More recently, a large, multicentre randomized controlled trial (RCT) provided further evidence for the value of PFMT for POP (Hagen *et al.* 2014). Pelvic organ prolapse is defined as "the symptomatic descent of one or more of: the anterior vaginal wall, the posterior vaginal wall, and the apex of the vagina (cervix/uterus) or vault (cuff) after hysterectomy" (Abrams *et al.* 2010, p. 214). It affects approximately 40% of women aged 50 years and over, and can lead to symptoms such as UI, faecal incontinence, and voiding, defecation and sexual dysfunction (Hendrix *et al.* 2002). The RCT by Hagen *et al.* (2014) investigated the effect of individualized PFMT on POP symptoms in 447 women. The study found that women who carried out PFMT over at least 16 weeks reported a significantly greater reduction in the POP symptom score at 6 and 12 months compared to the control group, who received an information leaflet but no instructions about PFMEs ($P < 0.0001$ and $P = 0.0053$, respectively).

Pelvic floor muscle training aims to improve strength, endurance and coordination in order to increase structural support for the pelvic organs (Hagen & Stark 2011), and to help prevent UI by increasing urethral closing pressure during rises in intra-abdominal pressure that may occur with effort or exertion (Bø 1995). The principles of specificity and overload are essential for strengthening the PFMs, and the strengthening process can take several months because of the time required for muscle physiology changes and hypertrophy (Bø 1995). Importantly, positive treatment outcomes rely on patient adherence to PFMT. However, it is known that adherence and completion of prescribed exercises is poor (Fine *et al.* 2007; Whitford *et al.* 2007), despite patients acknowledging the benefits of exercise (Hay-Smith *et al.* 2007). Poor compliance has also been documented in research specifically related to PFMT, with adherence rates tending to decline over time (Bø & Talseth 1996; Fine *et al.* 2007).

In some qualitative studies, examples of the reasons given for not adhering to PFMEs are forgetfulness, lack of time, being unsure about whether the PFMEs were being performed

Table 1. Examples of barriers to and facilitators of adherence to pelvic floor muscle (PFM) exercises: (UI) urinary incontinence

Barrier	Facilitator
Forgetfulness/trouble remembering	Completing exercises at a regular time of day
Lack of time	Use of alarm reminders
Uncertainty about correct PFM contraction	Other reminders (e.g. from family members)
Uncertainty about the benefit of exercises	Perceived symptom bothersomeness
Not seeing an obvious reward	Knowing other sufferers of UI
Resignation about the problem of UI	Wanting to prevent future problems

correctly, uncertainty about the benefits, not being able to see an obvious reward and resignation to the problem of UI (Ashworth & Hagan 1993; Hay-Smith *et al.* 2007; Siu & Lopez 2012). One study found that the most frequently reported barrier to adherence during supervised treatment, as well as at 3 and 12 months after randomization, was ''trouble remembering to do exercises'' (Borello-France *et al.* 2013, p. 765). This was also a predictor of being significantly less likely to adhere to exercise recommendations. On the other hand, examples of facilitators to adherence to PFMEs include: completing exercises at routine times of the day (Hines *et al.* 2007); the use of alarm devices (Sugaya *et al.* 2003) or other reminders, such as visual cues around the home (Siu & Lopez 2012); the perceived troublesomeness of symptoms (Paddison 2002; Siu & Lopez 2012); and knowing other sufferers of UI and wanting to prevent future problems (Mason *et al.* 2001). Table 1 summarizes these barriers to and facilitators of adherence.

One method that has been used more recently to address some of the barriers and facilitators listed above, as well as to disseminate treatment advice, is the use of technology including iPhone apps. These apps can be accessed and downloaded by any member of the public who owns an iPhone, but some individuals may not have the adequate knowledge to critically evaluate the information that is provided by the app. As has been pointed out, ''it is often unclear whether the recommendations in the app are based on the most current evidence for clinical practice or what the source of the recommendation is'' (Murfin 2013, p. 38). In applying existing knowledge in relation to exercise adherence, an effective app for PFMT should provide: up-to-date, accurate and evidence-based education about the PFMs, and instruction on how to contract these muscles (Bø 2007); an avenue for the progression of exercises (Bø & Aschehoug 2007; ACSM 2009); a way to set reminders for exercises (Sugaya *et al.* 2003); and a means of recording exercise accomplishments (Woodard & Berry 2001). These hallmarks could help to tackle the common obstacles of forgetfulness and the patient-reported barrier of feeling uninformed (Hay-Smith *et al.* 2007), and may help to boost motivation to adhere to PFMEs.

Materials and methods

A search on the UK Apple App Store was performed on 29 January 2014 using an Apple iPhone. The search terms ''pelvic floor'' and ''Kegel'' were used. Pelvic floor muscle exercises are commonly known as Kegel exercises in North America. These are named after Arnold Kegel, the American gynaecologist who was the first clinician to describe these exercises in the medical literature. The apps included in the analysis were those: that were compatible with the Apple iPhone; in the English language; with a clear primary aim of teaching or promoting PFMEs; and that cost of £5.00 or less. The cost of the apps was limited to £5.00 because users often choose to download apps based on price, and it was thought that a higher cost might be a barrier to some patients. Apps that specifically targeted a post-operative audience (e.g. those who had undergone a hysterectomy or a Caesarean section) or only recently postnatal women, and that did not focus chiefly on PFMEs were excluded from the analysis. Apps that solely provided education about general Pilates or global strengthening exercises were also excluded. The results of the search strategy are shown in Fig. 1.

Each eligible app was downloaded from the Apple App Store, then trialled and assessed by one of the present authors (A.H.). The reviewer read all the information, or watched the videos contained within each app or accessed via hyperlinks, then tested the app functions and features. The content and accuracy of the information, and the functions in the apps intended to promote adherence to PFMT and strengthening were evaluated against the recommended

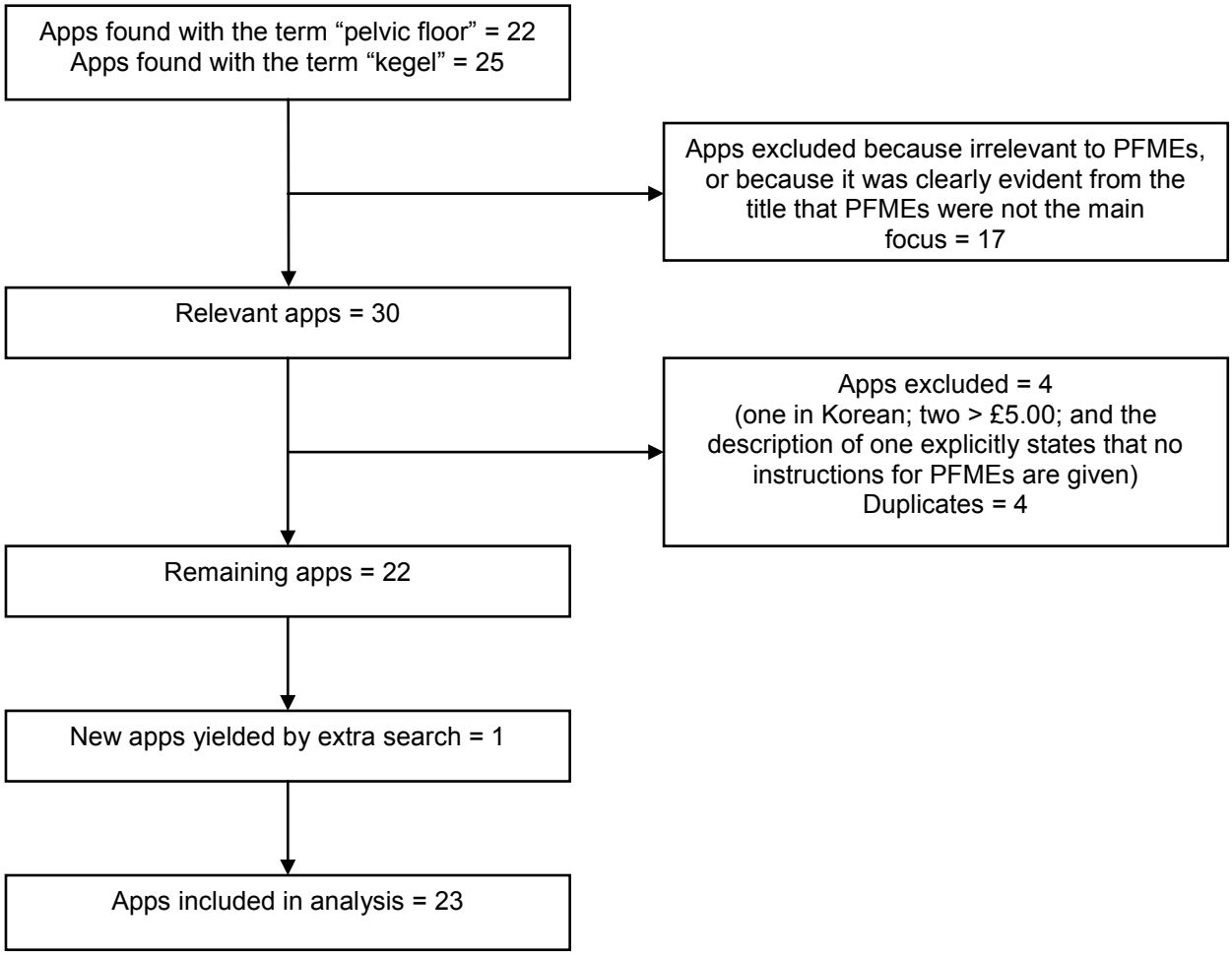

Figure 1. Results of the search strategy: (PFMEs) pelvic floor muscle exercises.

treatment guidelines (NICE 2013), and tested for usability. Thus, the four key criteria that were developed for the content analysis, against which the apps were compared and evaluated, were the provision of:

- education;
- exercise reminders;
- exercise progressions; and
- the facility to record exercises.

The educational element comprised information about the anatomy and role of the PFMs, and instruction on how to contract these muscles correctly. This is information that would be discussed routinely in the clinical setting by a physiotherapist when treating women with PFM dysfunction. After testing each app, the results regarding whether, and the extent to which, each of the criteria was attained were tabulated along with supporting evidence/text from the app.

Results

The initial search identified 47 apps (22 results from searching ''pelvic floor'' and 25 results from ''Kegel''), 17 of which were excluded because it was clear from the app names that these were either not relevant to the PFMs, or PFMEs were not the main focus. Four of the remaining 30 apps were also excluded: one was not in the English language; two cost more than £5.00 to purchase; and the App Store description explicitly stated that one was an interval timer and did not give instructions on how to exercise. If an app was available as both a free and paid upgrade version, these were considered as separate apps in case their content differed. After removing duplicate results, a total of 22 apps were left. As apps are frequently updated and developed, a further search was carried out on the App Store on 10 March 2014, leading to the discovery of one new app. Thus, a total of 23 apps were included for analysis. An overview of the main characteristics of the apps included is given in Table 2.

Table 2 and the classification system used to grade the apps were created to facilitate comparison and analysis. The apps are presented in alphabetical order and numbered. Where an app

Table 2. Overview of the main characteristics of the apps included in the study: (PFMC) pelvic floor muscle contraction; (+) the criterion was met, and was in accordance with current evidence and guidelines; (−) the criterion was not addressed by the app; (?) an attempt was made to address criterion, but there was a lack of information, inaccurate information, or a function that did not comply with current guidelines or had limited usability; (PFF) pelvic floor fitness; and (NHS) National Health Service

				Education				
Number	App	Developer	Cost	Anatomy/ role	PFMC instruction	Exercise reminder	Exercise progression	Exercise record
1	Birdi	Birdi Solutions	Free – app only (upgrade Birdi: Basic=€210; Birdi Plus with probe kit=€ 270)	–	–	–	+	–
2	BladderTrakHer	American Urogynecologic Society	Free	+	+	+	–	–
3	Get Bladder Fit	Astellas	Free	+	+	+	?	+
4a	Goldmuscle Lite	Gold App	Free	?	–	?	?	?
4b	Goldmuscle	Gold App	£0.69	?	–	?	+	?
5	iDry	Three Ten LLC – supported by the National Institute on Aging	£2.99 (free version has no reminders)	–	–	–	–	–
6	iKegel Buddy	Karen Barton	£0.69	?	+	–	–	–
7	iPelvic	The Java Boyz Ltd	£0.69	–	–	?	?	–
8	Kegel Aerobics	Coach on the Spot Productions LLC	£1.99	?	+	+	+	–
9	Kegel Camp	Sex with Emily	£1.49	?	+	?	+	?
10	Kegel Kat	Emma Assin	£0.69	?	+	–	+	–
11	KegelMate	Jong Bo Park	Free	+	?	–	+	–
12a	Kegel Trainer Lite	Olson Applications Ltd	Free	+	+	?	?	?
12b	Kegel Trainer	Olson Applications Ltd	£1.49	+	+	+	+	+
13a	KegelTunes – Kegel Exerciser (Free)	OriCo	Free	+	+	+	?	?
13b	KegelTunes – Kegel Exerciser (Upgraded)	OriCo	£0.69	+	+	+	+	+
14	My PFF	SCA Hygiene Products UK Ltd	Free	+	+	?	–	?
15	myKegel	Still Code	£1.49	?	?	+	+	–
16	Pelvic Floor Training – Motion is Life	Ralf Neumann	£0.69	?	?	–	?	–
17	Pelvic Floor and Kegel Exercises	Karen Barton	£1.49	+	+	?	?	–
18	Pelvic Floor First	Continence Foundation of Australia	Free	+	+	–	+	–
19	Pelvic Floor Trainer – Squeeze During Pregnancy and After Birth	GynZone ApS	£1.49	+	+	–	+	–
20	Squeezy – the NHS Physiotherapy App for Pelvic Floor Muscle Exercises	Propagator Ltd – endorsed by the NHS	£2.99	+	+	+	+	+

offers both free and paid upgrade options, these have been assigned the same number followed by the letters "a" for the free version and "b" for the upgraded option. In the classification system used within the table: a plus sign (+) in a category indicates that the criterion was met in accordance with current evidence and guidelines; a minus sign (−) shows that a criterion was not addressed within the app; and a question mark (?) signifies that an attempt was made to address a criterion, but there was a lack of information, a query about the accuracy of the information, or a function that did not comply with current guidelines or had limited usability.

Only three apps (12b, cost £1.49; 13b, cost £0.69; and 20, cost £2.99) fulfilled all four criteria of education, exercise reminders, exercise progressions and the facility to record exercises.

Costs and developers

The prices of apps in the under £5.00 category ranged from free to £2.99. Nine apps (1, 2, 3, 4a, 11, 12a, 13a, 14 and 18, as per Table 2) were available for free. Of those, three (4b, 12b and 13b) offered a paid version (ranging from £0.69 to £1.49) with additional features, such as: extra levels for exercise progression (4b, 12b and 13b); customizable exercise settings (12b and 13b); the ability to set more than two reminders (12b); and the ability to track progress with an exercise log (12b and 13b). One app (5) was available in both free and paid versions, but because the free version did not promote PFMEs, only completion of a bladder diary, it did not meet the inclusion criteria and, thus, was excluded. Therefore, only the upgraded version was included in analysis.

A range of people and companies developed the apps, with seven (2, 5, 8, 9, 16, 19 and 20) appearing to be curated or endorsed by health professionals. Three (2, 5 and 8) contained advice from medical practitioners, two (16 and 20) contained advice from physiotherapists, one (19) had the endorsement of a doctor, physiotherapist and midwife, and one (9) was a product created by a sex therapist. Two apps were affiliated with large medical or health promotion associations, i.e. the American Urogynecologic Society (2) and the Continence Foundation of Australia (18), and two were supported by pharmaceutical or hygiene product companies (2 and 14).

Provision of education and information

Eleven apps (2, 3, 12a, 12b, 13a, 13b, 14, 17, 18, 19 and 20) contained correct and sufficient information related to PFM anatomy and functions, as well as clear instructions on how to contract the PFMs that were in line with current clinical practice. Three apps (1, 5 and 7) did not include any educational element. The remaining nine apps (4a, 4b, 6, 8, 9, 10, 11, 15 and 16) provided incomplete, unclear or inaccurate information (i.e. for which there is a lack of evidence). For example, one claimed that Kegel exercises could help to improve urinary-tract-related diseases (4a and 4b), and another stated that, besides pregnancy, infrequent sex and/or infrequent masturbation was a "cause of urinary and bowel incontinence and collapse of vaginal walls" (8). Some apps included information, but poor English language translation may have led to the use of ambiguous words and phrasing, such as calling the urethra the "bubble passage" (16), or stating that the aim of the app is to "provide a learning to manipulate the muscles inside" [sic] (11). Some lacked detail when describing the PFMs, only referring to the pubococcygeus muscle (4a, 4b, 9, 10 and 15), or neglected to fully describe the role of the PFMs; for example, the important role of these muscles in the support of pelvic organs (6, 9).

Four apps (14, 17, 18 and 19) presented information using videos, and two (13a and 13b) used hyperlinks to external sources; for example, the Mayo Clinic, a non-profit research centre based in the USA (MFMER 2014). The remaining apps (2, 3, 12a, 12b and 20) gave written information.

Different images and visuals were used in each app to prompt PFMEs (for examples, see Fig. 2). Three of the apps (4a, 4b and 10) sought to make PFMEs "fun" by using characters, such as a cat with differing facial expressions during the hold and relax phases (10), or characters resembling warriors (4a and 4b) who collect gold coins as the exercises are completed. Another app (1) used an animation of a weight-lifting character. Other visuals included a progress bar (4a and 4b), or text instructions and changing colours to show contraction and relaxation phases (8, 9, 11, 14, 15 and 20). Some apps additionally included a countdown of the hold time (12a, 12b, 13a and 13b). Three just displayed a timer (3) or countdown without any prompts to contract (6 and 17).

Exercise reminders

Nine apps (2, 3, 5, 8, 12b, 13a, 13b, 15 and 20) enabled users to set at least three reminders per day by setting an alarm or text alert. Five (4a,

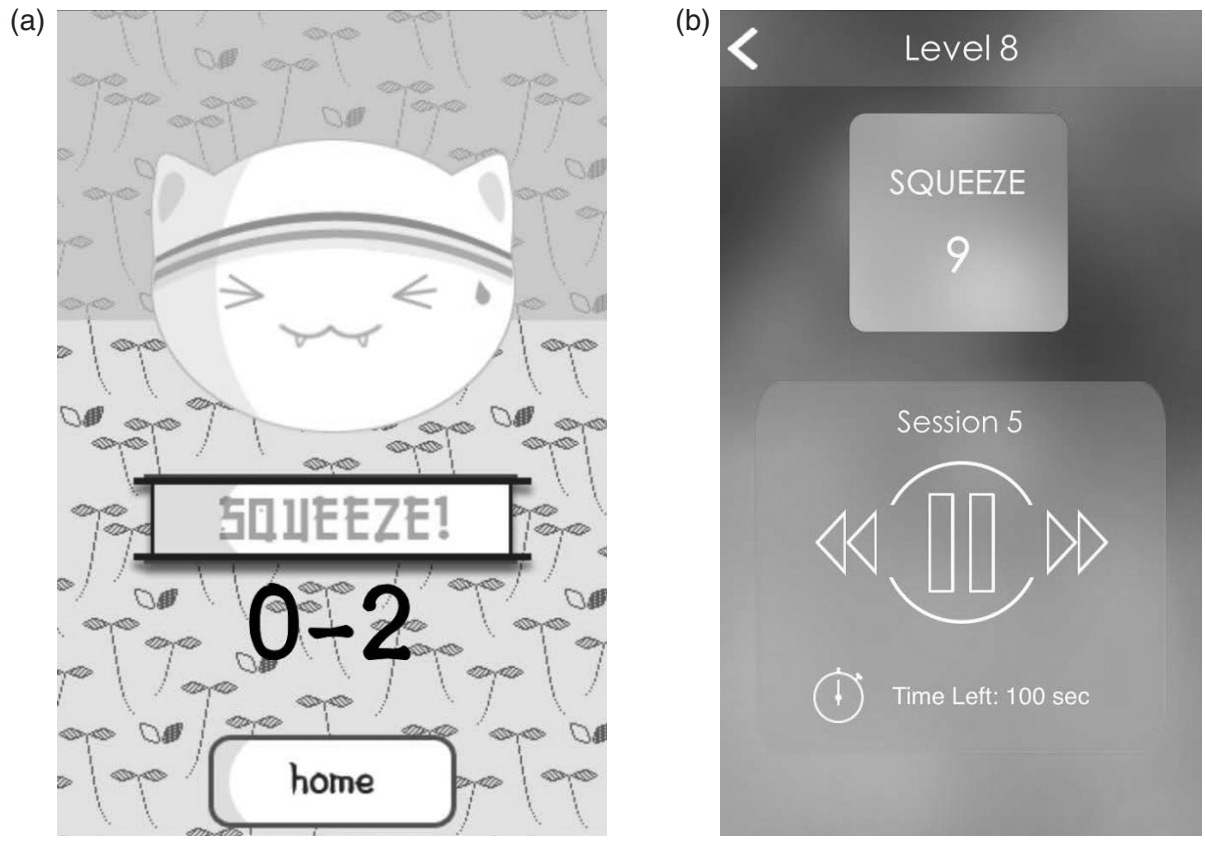

Figure 2. Examples of visuals designed to prompt pelvic floor muscle contraction: (a) Kegel Kat (app 10); and (b) Kegel Trainer (app 13b).

4b, 9, 12a and 14) allowed a reminder to be set, but not at a frequency that complied with treatment guidelines. One (17) did not have an in-built reminder function, but directed the user to the external phone calendar. Another (7) provided six daily reminders, but the alert times were unspecified and could not be selected, limiting usability. Seven apps did not provide the ability to set any reminders.

Exercise progression

Twelve apps (1, 4b, 8, 9, 10, 11, 12b, 13b, 15, 18, 19 and 20) gave users the capability of increasing exercise levels (i.e. holds and repetitions) to progress their endurance and strength programmes. Of these, five (10, 12b, 13b, 15 and 20) allowed users to customize muscle contraction times and repetitions by changing settings within the program according to their ability. One app (20) offered a ''Professional Mode'' for use in conjunction with treatment from a healthcare professional, in which additional options such as submaximal contractions and the speed of the ''quick exercises'' could also be set. Three of the free apps (4a, 12a and 13a) offered a number of levels to progress through, but being limited to 4–6-s holds, these were of an insufficient intensity to achieve maximal strengthening. However, extra levels were accessible in the upgraded versions of these three products. One app (6) suggested 5 min of squeezing three times a day, but gave no further instructions. Two (2 and 5) did not mention the principle of exercise progression at all. Progressions in the body position in which PFMEs could be performed (e.g. in standing) were also provided in some apps (14, 16, 17 and 19).

Exercise recording

Thirteen apps (1, 2, 5, 6, 7, 8, 10, 11, 15, 16, 17, 18 and 19) did not contain a function to log exercises. Six (4a, 4b, 9, 12a, 13a and 14) provided users with some feedback about the number of completed exercises on a particular day (4a and 4b), in the previous week (9) or the date that the exercises were last completed (12a, 13a and 14). However, four apps (3, 12b, 13b and 20) provided access to longer-term exercise data, and completed levels or hold times. Methods included a display of exercise logs with a graph showing the longest hold achieved (3), and displays of average exercise frequency in the past week and month (12b), and up to 2 years earlier (13b). App 20 logged the dates of exercise

completion, as well as a percentage score showing the rate of completed exercises compared to what was initially planned.

Additional functions

For women with symptoms of overactive bladder, some apps also incorporated medication reminders (2, 3 and 5) and bladder diaries (2 and 5) to help with bladder training. For more general exercises that were not detrimental to the PFMs, one app (18) offered low-impact cardiovascular and resistance workouts.

Most apps were designed for women; however, five (4a, 4b, 9, 10 and 15) also included some information about the benefits of PFMT for men, such as stronger erections (9 and 15), enhanced sexual function (4a and 4b), and improvements in prostate pain and UI symptoms (10 and 15). There is evidence to suggest that PFMT can improve erectile function (Dorey *et al.* 2005) as well as UI in men, particularly in those who have undergone prostate surgery (Filocamo *et al.* 2005; Manassero *et al.* 2007; Overgård *et al.* 2008), suggesting that these apps may also be useful for this client group.

Although the analysis only included English-language apps, it was worth noting that two of those analysed were also available in other languages such as Arabic (16), and Danish, Norwegian, Swedish and German (19). Another (1) included Spanish and French advice on its companion website.

Discussion

iPhone apps that promoted PFMEs varied in content, with only three out of 23 apps fulfilling the four key criteria being evaluated for this review, i.e. the provision of education, exercise reminders, exercise progressions and the means to record exercises.

Costs and developers

The higher cost of an app did not necessarily dictate the depth and accuracy of information within it, but may have just reflected the pricing strategy of each developer to cover development costs and/or generate revenue. For instance, two paid apps (5 and 7) did not offer any education about PFMs, whereas other free apps (3, 14 and 18) provided detailed instruction. Two free apps (3 and 14) were sponsored by large companies. It is important to be aware of the funding and development source of any app since this may influence the particular treatment options that are included (Murfin 2013). For example, current guidelines recommend bladder training for at least 6 weeks as a first-line treatment for women with UUI or MUI, which may be symptoms of overactive bladder (NICE 2013). The app (3) from Astellas (a manufacturer of medications for overactive bladder) offered a bladder diary function; however, advice about for the treatment of overactive bladder focused on medication and did not include bladder training.

In addition, information in the apps that was written by a medical professional was not always evidence-based. One written by a sleep disorders specialist (8) stated that infrequent sex and/or infrequent masturbation could be a ''cause of urinary and bowel incontinence and collapse of vaginal walls'' as ''orgasm is the way PFMs are kept toned and fit''. This is an unfounded assertion that is not supported by the current literature, and it could also be discouraging to app users who may not be sexually active. Several papers support the idea that increased PFM strength improves sexual function and orgasm (Beji *et al.* 2003; Lowenstein *et al.* 2010; Martinez *et al.* 2014), but there is a paucity of evidence to suggest that orgasms contribute to strong PFMs.

Provision of education and information

According to Bø (2007, p. 5), the mainstay of physiotherapy treatment of PFM dysfunction is ''education about the dysfunction, information regarding lifestyle interventions [. . .] and PFMT'', which should include the teaching of the correct contraction techniques.

Although 11 of the 23 apps (2, 3, 12a, 12b, 13a, 13b, 14, 17, 18, 19 and 20) provided education about the anatomy and role of the PFMs, some included inaccurate or incomplete information. Five referred only to the pubococcygeus muscle (4a, 4b, 9, 10 and 15) despite the PFM complex including the levator ani muscles (i.e. the pubococcygeus, iliococcygeus, ischiococcygeus, pubovaginalis and puborectalis) and more superficial muscles (Haslam 2004). In some instances, this may be attributed to international differences in terminology (9), or app authors possibly referring to Dr Kegel's early papers (e.g. Kegel 1952), which only refer to the pubococcygeus muscle (15). Others (4a, 4b, 6 and 9) did not describe the chief roles of the PFMs being the support of the pelvic organs and the maintenance of continence (Haslam 2004). This may have been because of the specific aim of some apps; for example, Kegel Camp (9) aimed to

emphasize the role of the PFMs in sexual pleasure, rather than as a treatment for UI or POP. Two (4a and 4b) claimed that Kegel exercises could help to improve ''urinary-tract-related diseases''. The general term ''urinary-tract-related diseases'' could encompass conditions like bladder cancer, interstitial cystitis and kidney stones, for which there is no evidence that PFMEs are effective.

In some cases, inaccurate information was possibly a result of poor English translation from a foreign language. One app (16) originating from Germany used non-standard English terms, such as the ''bubble passage'' and ''the washbasin'', presumably in reference to the urethra and pelvis. Additionally, the contraction phase of the PFMEs was termed ''the strain phase'', which could encourage app users to strain or bear down during PFMEs rather than squeeze and lift up. It is important that education is provided about how to contract the PFMs correctly since straining ''may permanently stretch, weaken and harm the contractile ability of the PFM[s]'' and ''stretch [. . .] fasciae and ligaments [. . .] increasing the risk of development of pelvic organ prolapse'' (Bø & Mørkved 2007, p. 114–115). For the same reason, the visuals within an app also have the potential to be misleading. The animation of a cat with a facial expression of straining (10) or the cartoon of a weight-lifting character (1) may lead users to believe incorrectly that PFM contractions involve a lot of exertion, and may potentially cause bearing down or use of accessory muscles.

It is arguable that the criterion of education in an app is perhaps less crucial than the other functions if it is to be used in conjunction with treatment from a physiotherapist, although this seemingly conflicting information could potentially cause confusion and adversely affect patient outcomes. In a clinical setting, it would certainly be the physiotherapist's role and responsibility to provide information to patients, and to ensure that they were taught how to contract their PFMs correctly. In this circumstance, the use of an app would function as an adjunct to treatment.

Exercise reminders

The most common barrier to adherence to PFMEs that was identified by Borello-France *et al.* (2013, p. 765) was ''trouble remembering to do [the] exercises''. Sugaya *et al.* (2003) found that a chiming device, set to sound three times a day, helped to increase patient compliance with PFMEs, which improved UI and QoL compared to the control group, who only received a leaflet on PFMT.

Current treatment guidelines recommend that PFME programmes should include eight contractions performed three times per day (NICE 2013). Therefore, an effective app should enable users to set an alarm or text alert at this frequency as a minimum. Nine apps (2, 3, 5, 8, 12b, 13a, 13b, 15 and 20) enabled users to set at least three reminders per day by creating an alarm or text alert. Another (7) provided six daily reminders; however, the alert times were unable to be specified by the user, which was inconvenient and restricted usability. Completing PFMEs at set times of the day or as part of a daily routine that occurs at a set time helps to improve exercise adherence (Hines *et al.* 2007). Hines *et al.* (2007) found that women who used a routine approach for PFMT were 12 times more likely to adhere to exercises at 3 months, and significantly more likely to maintain compliance levels at 12 months ($P<0.014$) compared to an *ad hoc* or sporadic approach.

Exercise progression

The PFMs adapt to strength training in the same way as other skeletal muscles (Bø & Aschehoug 2007). The principle of progressive overload, which is the gradual increase of stress placed on the body during exercise training, is essential to increase muscle strength (ACSM 2009). Overload may be achieved by altering variables, such as increasing the number of repetitions, sustaining contraction time, shortening rest periods between contractions and increasing the speed of contraction (Bø & Aschehoug 2007; ACSM 2009). Thus, apps that allowed the customization of repetitions, and hold and rest times were preferable (10, 12b, 13b, 15 and 20). Only one of these (20) allowed the speed of PFM contractions to be altered. Apps that capped the PFM contraction time at 4–6 s (4a, 12a and 13a) may not have provided some users with enough of a challenge to cause strength gains. Exercise progression was also provided in some apps by recommending changes in the body position in which PFMEs were performed (14, 16, 17 and 19), moving from supine to sitting to standing. In standing, PFM contraction is more difficult because the muscles must contract against increasing gravity (Bø & Aschehoug 2007), and some patients will require specific training in this position.

Exercise recording

Paper diaries completed by patients are the most common measure of adherence to home programmes in physiotherapy practice (Jack *et al.* 2010). However, there may be a tendency for some patients to over-report their exercise levels, and details of exercise completion (e.g. the date or duration) may not be accurate if recording in the log does not happen in a timely manner (Yuen *et al.* 2013). The facility to record exercise completion within apps may help to improve the accuracy of data regarding adherence since the exercise session is logged in real time.

One app (3) showed exercise data in the form of weekly exercise logs with a graph showing the longest hold achieved, which may help to evaluate progress and improve patient motivation. Other displays of data showing the average exercise frequency for the current day, and the past week and month (12b), as well as any levels completed (13b), allow users to keep track of workout sessions and improvements in endurance. Users are also able to share information about the rate of compliance in one app (20), where a percentage score of completed exercises compared to exercises prescribed is given, although this does still rely on the users' honesty in relation to completion of the exercises.

Additional functions

Two apps (2 and 5) provide bladder diaries, which may be a useful addition because, in practice, these are often used by patients undergoing bladder training. Such diaries are recommended as a first-line treatment for UUI or MUI (NICE 2013).

For women with UI and/or POP who are eager to engage in other general exercise regimes for cardiovascular fitness and strengthening, the selection of appropriate exercises is important so as to minimize the risk of developing or worsening POP. Activities such as weight-lifting, and high-impact forms of exercise like aerobics or long-distance running are to be avoided (Balmforth & Robinson 2007). Thus, the provision of low-impact aerobic and resistance workouts in one app (18) could be a welcome option for many women.

Limitations of this study

The omission of the terms "incontinence" or "leakage" in the search could be considered a limitation of the present study, and may possibly have resulted in a failure to identify additional relevant apps. However, a subsequent search on the Apple App Store using these terms did not yield any new results that met the inclusion criteria for the analysis.

The present authors consider one limitation of this paper to be that only Apple iPhone apps were included in the analysis. The Android phone operating system also has a large subscription base and its own apps. A search for Android apps on Google Play on 1 May 2014 that used the terms "pelvic floor" and "Kegel" found that there were potentially eight missed apps that taught or promoted PFMEs, and a further three specifically for a male audience. Although these might have met all inclusion criteria for analysis, the search also found that nine apps were duplicates of some already included in the current analysis (1, 8, 10, 12a, 12b, 14, 16, 18 and 19).

Another limitation is the possible degree of bias relating to the critical evaluation of the apps, which was performed by only one reviewer (A.H.). At times when the reviewer experienced some uncertainty about issues such as how to classify apps for Table 2 or whether these met certain criteria, discussion with a second reviewer would have been useful and might have led to a different conclusion. Furthermore, the classification system used in the present review and the fulfilment of the criteria is not necessarily reflective of patients' perspectives on what would make an app enjoyable to use.

Finally, since apps are frequently upgraded, at which time the information and functions within the programs may be revised or added, the findings of this paper will need to be updated regularly.

Recommendations and implications for practice

Currently, existing PFMT apps do not all demonstrate information and functions that are evidence-based, and certain products would benefit from some revision. A number would benefit from minor changes to wording so as to avoid confusion. Several would benefit from the addition or revision of reminders in order to optimize exercise adherence, and others should address the principles of exercise progression and overload to promote muscle strengthening.

Generally, apps should be considered in a similar way to any Internet-based resource, and be critically evaluated using an evidence-based approach (Murfin 2013), especially before recommending the use of these products as a treatment adjunct. The results in Table 2 could be

used as a starting point to allow physiotherapists and other health professionals working with patients with UI and/or POP to identify apps that are available and the attributes these possess. Future content analyses of PFME apps should include those produced for Android, and involve more reviewers in order to corroborate results and minimize bias.

Only three of the 23 analysed apps (12b, 13b and 20) fulfilled all the criteria of education, exercise reminders, exercise progressions and the facility to record exercises, and would be recommended to patients in practice. Furthermore, of these three, one (20) was curated by a specialist women's health physiotherapist, peer-reviewed and endorsed by the National Health Service (NHS), meaning that it was relevant, used information from trusted sources and was in compliance with the Data Protection Act (NHS Choices 2014). The three apps all incurred a relatively small cost (between £0.69 and £2.99). However, app users often make their choices based on price and will opt for free ones before others that require payment. Taking this into account, of the nine free apps that were analysed, number 3 was the most robust, although there were some reservations about the exercise progression component. The in-built timer to measure PFM hold time was limited to 10 s, and relied on the user to start and stop it to correspond with the PFM contraction, which may prove difficult for some patients. Also, there were no prompts about the number of repetitions completed. Otherwise, exercise reminders and a record of maximal hold time were available, and the advice given was generally accurate and reliable. However, when considering the use of apps as an adjunct to clinical treatment rather than a standalone one, detailed information about the PFMs and their role may not need to be a compulsory inclusion since the physiotherapist should provide the patient with education in the clinical setting.

Ultimately, when deciding which app to recommend to individuals, this should be done in consultation with patients, and take into account their preference as well as the quality of the app. For example, where a woman prefers a more "fun" app, number 10 could be suggested. This recommendation is made despite reservations about the visuals potentially encouraging the wrong movement because this could be overcome if the patient's PFM contraction technique was first assessed and corrected in the clinic. For patients who prefer to be given advice or to follow exercise instructions through videos, numbers 14, 17, 18 and 19 could be useful, but the user may need a concurrent Internet connection since some videos may not be available offline, or the app may be a large file that will extend the time taken to download it. For patients who additionally need to complete a bladder diary and would prefer to record this electronically, number 2 could be suggested since a bladder diary and exercise reminders are provided, and the app is free. However, a search on the App Store specifically for "bladder diary" could yield further results.

Conclusion

To date, no other studies have evaluated iPhone apps that aim to teach and promote PFMT. The present content analysis has shown that not all available apps give accurate advice at this time, and neither do all have the functions required to optimize PFM strengthening or to prompt exercise completion at levels recommended by key treatment guidelines or research. Apps are generated by numerous developers, are generally unaudited and the sources of the information cited in the content are often unknown. Despite this, after critical evaluation, certain apps do appear to have a strong evidence base and would be worthy of recommendation in clinical practice. The use of apps is increasing exponentially, and these could be powerful tools for promoting and improving adherence to PFMEs, as well as effective adjuncts to physiotherapy treatment in the management of female UI and POP. Future studies should evaluate apps that have been used in a clinical setting in order to test the effectiveness of such programs and determine what role these may play in improving exercise compliance.

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