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The role of mobile applications in the conservative management of stress urinary incontinence in women

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Abstract

Urinary incontinence, affecting over 300 million women worldwide, regardless of race and age, is considered one of the most important health issues in the 21st century. Owing to the scale of the problem, the priority should be to provide therapy to as many patients as possible. Although effective conservative treatment measures for urinary incontinence are available, they may not cater for all individuals who seek help. Sometimes, a sense of embarrassment or a fear of stigmatization causes patients' reluctance to report urinary incontinence symptoms to their health care provider and to join therapy. That forces therapists to search for a new approach. In this field, the use of mHealth technologies seems very promising. They have become even more valuable during the COVID-19 pandemic, when the interest in telemedicine, as a means of providing care while not being exposed to the risk of virus infection, further increased. The purpose of this work was a narrative review showing possibilities of employing conservative measures to manage stress urinary incontinence in women, with a particular emphasis on the use of mHealth technologies, as recent studies have shown that mobile applications seem to be an effective tool in terms of improving stress urinary incontinence symptoms, satisfaction, and adherence to therapy.
Key words: mHealth, mobile apps, incontinence, pelvic floor muscles, physiotherapy

Introduction

Urinary incontinence (UI), defined as at least one incident of involuntary loss of urine, owing to its frequency of occurrence, is already considered a civilization disease [1]. The problem of UI affects mainly women. It is estimated that among the 423 million suffering from UI worldwide, there are 300 million women [2], regardless of race: 44% are Caucasian, 35% are Hispanic, and 29% are African American [3]. The rate of reported UI cases among women ranges from 5% to 72%, with an average of around 30%. These huge differences result from the fact that depending on cultural factors, place of birth, social status, or education, the problem is sometimes downplayed or perceived as embarrassing [4]. This is confirmed by the observation that about 55% of the respondents concealed their first symptoms of UI for fear of stigmatization, because of embarrassment, or owing to the belief that it was a physiological phenomenon [3].

Incontinence affects all age groups, but the risk of developing the disease increases with age. According to the estimates, the problem involves 30–40% of women before the menopause, while after the menopause, the rate increases to 60% [2]. Other sources report an incidence of incontinence equal to 51% of women overall, ranging from 13% in young, nulligravid women to 25% in reproductive-age, 47% in middle-age, 55% in postmenopausal, and 75% in elderly females [1, 3]. Among the several forms of UI, the most common one is stress UI (SUI) [2]. SUI affects 25–45% of women over 30 years of age [5]. In the group of young women, the main risk factor is the increasing load on the pelvic floor muscles (PFM) during pregnancy. The problem usually worsens in the third trimester, correspondingly fewer cases occur in the second and first trimesters of pregnancy. The prevalence of SUI among pregnant women around the world ranges from 18.6% to 60% [6].

SUI usually results from two, often coexisting, processes. The first is urethral hypermobility, which may be caused by the loss of support for the bladder neck and urethra, described in the literature as the so-called hammock hypothesis. The endopelvic fascia takes the form of a hammock, together with the urethral sphincter and the mucosa, effectively closing the lumen of the urethra and preventing uncontrolled outflow of urine during pressure changes in the abdominal cavity. Factors that weaken or damage the arcus tendinous fascia pelvis, such as childbirth, menopause, obesity, and chronic constipation, decrease the anatomical support of the bladder neck and the urethra. The consequence of this process is the lack of cooperation between the fascia and the urethral sphincter. Increased abdominal pressure reduces urethral pressure and causes urine leakage [4].

The second mechanism leading to SUI is damage, disruption, or weakening of PFM, mainly of the urethral sphincter or of the pubo-urethral ligament, which may be caused by trauma, surgery, or degenerative changes in the body [7]. Lung diseases, diabetes, and nicotine abuse are also factors predisposing to SUI. In addition, symptoms may be aggravated by high-impact exercise and the application of diuretics, including caffeine [4, 5].

Owing to the scale of the problem of incontinence, the priority should be to provide therapy to as many patients as possible. This possibility is provided by mHealth tools, i.e. mobile and wireless technologies to support the achievement of health objectives [8]. According to a report by the Office of Electronic Communications in Poland, over 60% of Poles access the Internet on their smartphones, and almost half of them use mobile applications [9]. This reflects the enormous

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potential of this type of tools to improve health as a supplement to traditional forms of therapy. Moreover, during the COVID-19 pandemic, the interest in telemedicine, as a means of providing care while maintaining social distance and not being exposed to the risk of virus infection, has further increased [10]. The global epidemiological situation has in some way forced a turn to such forms of therapy. They seem to be a promising prospect, also in urogynaecology. The effectiveness of remote therapy in SUI has already been confirmed by first studies [11, 12]. The conclusions of a systematic review on the use of telemedicine in the COVID-19 pandemic for treating various disease entities also suggest that mobile applications can be an effective and safe tool supporting the treatment of SUI by facilitating unsupervised PFM training (PFMT) [13].

In addition, it is suggested that the use of mobile health applications may also improve the level of adherence to therapeutic recommendations [10]. The scale of patients' noncompliance with physiotherapists' recommendations is difficult to determine. According to the World Health Organization, the level of adherence among chronically ill patients is only 50% and constitutes a serious therapy impediment [14]. Studies show that the problem of the lack of long-term discipline in performing the recommended PFM exercises concerns up to 2/3 of patients with UI [15]. Continuous adherence is the basis for achieving and maintaining results in SUI therapy, while low adherence leads to a long-term decline in effectiveness [16]. World Health Organization experts emphasize that compliance improvement may bring greater health benefits than an improvement of a specific therapeutic method [14]. Therefore, methods to improve adherence, such as the use of mobile applications, are worth the attention of both researchers and clinicians. Therapeutic strategies, including mobile technologies, are the subject of this study. The article is a narrative review based on a search of world scientific literature. However, because of a small number of publications found in scientific databases (Web of Science, PubMed, MEDLINE, EBSCO, Scopus, Google Scholar) with reference to the use of mobile applications in treating incontinence in women, the authors decided not to conduct a formal systematic review.

SUI diagnosis and conservative treatment

SUI diagnosis should begin with taking detailed history, conducting a physical examination, as well as filling out questionnaires specifying the scale of the problem, pain symptoms, and the impact on the quality of life. It is helpful to use a voiding diary to estimate the fluid intake and excretion, and cough stress tests of very good reliability, sensitivity, and specificity [17]. In order to confirm and expand the diagnosis, urogynaecological ultrasound and urodynamic examination are performed. It is also important to exclude diseases that require urgent consultations and treatment with other specialists [4]. The most valuable form of examination is palpation of the perivaginal muscles performed *per vaginam*. The assessment should include evaluation of PFM strength and endurance, and reflex activity. The most common, easy to perform but reliable and reproducible tool is the PERFECT scheme. The examination includes: strength of voluntary contraction, endurance, performance of slow-twitch and fast-twitch muscle fibres, PFM contraction pattern, co-activation of the transverse abdominal muscle, and involuntary contraction in response to increased intra-abdominal pressure [18, 19]. In the case of improper PFM tonus, physiotherapy should be applied.

SUI treatment should be initiated with conservative measures, regardless of the patient's age. Conservative therapy is effective in mild and moderate SUI cases. In a more advanced stage, or in women whose symptoms do not improve sufficiently with conservative therapies, surgery is required, and physiotherapy is applied as preoperative preparation and postoperatively [5]. Pessaries are also helpful in therapy or used as a safeguard in more advanced stages. Their purpose is to mechanically compress and support the urethra [4]. Urogynaecological physiotherapy should take into account behavioural changes: lifestyle modifications, reducing body weight to the level of the correct body mass index, ensuring adequate hydration, stopping smoking, and training the bladder by regularly increasing the intervals between micturitions. The key, however, is to improve function and PFM strength [4–6].

PFMT and manual therapy

PFMT involves performing selective and voluntary muscle contractions, followed by their conscious and gentle relaxation. For this purpose, various physiotherapeutic techniques are used to teach the patients about proper PFM functioning and increase their body awareness [6]. Activating exercises are designed to strengthen muscles with low muscle tone, while exercise and relaxation techniques will affect the relaxation of muscles with high tonus. To eliminate SUI symptoms, it is necessary to obtain proper cooperation between the structures that build the pelvic floor, both passive (fascia, ligaments) and active (PFM). The proper functioning of the entire pelvic floor complex is particularly important in situations that increase pressure in the abdominal cavity, such as laughing, coughing, and sneezing. Learning to activate PFM in the above circumstances should be included in PFMT [20]. Correct body posture is also essential to restore appropriate pelvic floor function. Its disorders may lead to PFM weakening and, consequently, cause or worsen SUI symptoms [21]. The whole treatment is completed with a correct breathing pattern. Adequate breathing is also a prerequisite for effective hypopressive exercise. Such exercises, proposed by Caufriez, practised in SUI therapy, include the reflex activation of PFM and the transverse abdominal muscle by performing specific breathing exercises combined with changes in body position [22]. Exercising to strengthen PFM is one of the basic forms of SUI therapy, bringing improvement in functioning in 29–59% of patients. In individuals who have difficulties with the initiation of PFM contraction, auxiliary equipment may be used in the form of the so-called educators. These can be weighted vaginal cones, which facilitate PFM activation [5]. Biofeedback methods can also be applied for instructional purposes. The most frequently used method to obtain feedback is sonofeedback, i.e. imaging of a PFM contraction with an ultrasound probe [23]. Surface electromyography is also utilized in biofeedback, with a vaginal probe transmitting the read signal of pressure changes caused by a PFM contraction [24]. The patient's task is to perform a contraction of such a force that normal physiological values will be shown by the indicator. In women who learn how to properly train PFM, an educator can be used to evaluate the therapeutic results [25]. For optimal effects, PFMT should be complementary to other physiotherapeutic methods. Dry needling [26], massage [27], release of trigger points [28, 29], as well as physical methods can be applied to improve blood supply, regenerate cells, increase muscle contractility, reduce pain, and diminish muscle tension.

Physical therapy

One of the most effective forms of therapy, especially in combination with conscious PFM activation and biofeedback, is electrostimulation. Both surface and vaginal electrostimulation bring very good results [30, 31]. According to Pereira et al. [31], a series of electrostimulation treatments performed twice a week for 6 weeks significantly alleviates SUI symptoms. In addition to decreasing the number of urine loss incidents, electrostimulation also reduces nocturia and prolongs the time between micturitions. Fürst et al. [32] demonstrated the maintenance of the above electrostimulation effects 3 months after the end of therapy. However, as electrostimulation treatment, despite its positive effects, may cause discomfort in some patients, it is not recommended as the first-line procedure in SUI.

Vibration training may be a good alternative. It is a type of exercise performed on a vibrating platform, which is safe and comfortable. Vibrations of a certain frequency and amplitude cause changes in the length of muscle spindles, which, in turn, activate α-motor neurons, leading to contraction. The vibrations also increase the synchronization of the motor units, which means that more muscle fibres are contracted at the same time and therefore the contraction becomes more forceful. The contraction caused by vibration training is stronger than voluntary contraction [33]. The contraction strength depends on the parameters of the procedure, but also on the position of the patient's body and the flexion angle in the knee and ankle joints. Vibration training shows promising results [34] and may be worth considering as an alternative to standard exercises [35].

High-intensity focused electromagnetic field (HIFEM) therapy may also be an effective solution. The alternating magnetic field generated by an electrified coil induces the flow of ions, creating eddy currents in the tissues. Their purpose is to depolarize the motor nerve and create an action potential that triggers muscle contractions. The higher the level of the action potentials, the more effective and selective the contractions. In turn, the structure of the field is influenced by the field frequency. Lower field frequencies will inhibit the bladder detrusor, and higher ones will be more effective in stimulating PFM contractions and urethral closure. HIFEM impact on peripheral nerve stimulation, muscle activation, and improving blood circulation and composition of collagen structures have been proven [36, 37] Samuels et al. [37] demonstrated that after 6 HIFEM sessions, patients benefited from a decreased severity of UI symptoms and a reduced usage of absorbent pads. They also reported a better control of urination, as well as increased sexual satisfaction, which positively influenced the patients' quality of life. Moreover, owing to such advantages as the lack of an internal probe, no supervision requirement, and the ability of the magnetic field to penetrate through clothing, HIFEM is a very convenient and well-accepted therapeutic method [38].

Mobile applications

Along with the increasing availability of mobile devices and interest in telemedicine, more and more applications for monitoring and improving health condition appear on the global market. Currently, over 100,000 health applications are available on the Apple App Store and Google Play Store. They are used to monitor health parameters, physical activity, and diet on an ongoing basis, but also allow searching for information about diseases, their symptoms, and treatment methods. More advanced applications allow users to create goals, plans for their implementation, and comparative charts that may motivate a lifestyle change. Such solutions are also available to support prevention of urogynaecological disorders, although only a few applications are available in Polish so far and some of them require the purchase of specialized exercise equipment for full use. Their basic functions include the preparation of a PFMT plan, along with a regular reminder to perform exercises and the possibility of marking them in the calendar. Exercise instructions can be presented in a descriptive form or in a voice version, by the so-called virtual trainer, providing information about the contraction duration, the relaxation phase, and the number of repetitions. Apps with voice guidance are a better solution. The research by Wang et al. [39], performed in a group of primiparous women with the SUI problem, showed that this form helps achieve better results as compared with apps presenting only written guidelines describing how to perform PFMT.

Exercises are divided into training days assigned to the appropriate level of advancement. Completion of subsequent workouts allows for the progress of exercises in the form of extending the duration of a single workout, increasing the number of repetitions and series, or prolonging a single contraction. The applications can be supplemented with an educational component – instruction on the location of PFM, their role in the prevention of urogynaecological disorders and in preparation for pregnancy and childbirth, health benefits of regular exercise and proper muscle strength, and the consequences of PFM weakening. Despite many functionalities of the application, exercises performed in accordance with their guidelines are not subject to specialist supervision, which seems to be their biggest disadvantage. A study by Fitz et al. [40] confirmed that supervised training was more effective than one performed without the control of a physiotherapist. The problem is the quality of self-exercise. Bø et al. [41], using a transvaginal ultrasound probe, demonstrated that in some women, during exercise, along with the activation of the transverse abdominal muscle, PFM became displaced rather than elevated. On the other hand, Baeßler and Junginger [42] showed that during yoga and Pilates exercises without prior PFM activation, the bladder neck might be lowered by up to 17 mm. In a study by Barton et al. [43], the percentage of women who were unable to tighten PFM without lowering the bladder neck was estimated as 25%, but in a paper by Thompson et al. [44], this rate already equalled 43%. In turn, among women with pelvic floor disorders, even 70% were unable to generate a proper PFM contraction [45]. The above results highlight the risk of exercising without a supervision by a specialist.

In order to improve the safety and effectiveness of exercises, the creators of more extensive applications include an option of a urogynaecological physiotherapist consultation. The effectiveness of PFMT is also to be expanded by exercise equipment – vaginal probes/educators. In applications that do not use additional tools, there is no feedback on the correctness of the exercises performed and no control of the therapy effectiveness.

Moreover, there is a lack of information based on scientific evidence. Systematic reviews of PFMT applications for SUI used in Brazil and New Zealand indicated the lack of scientific basis to assess the effectiveness of the applications, which lowers their rating [46]. Only a small number of applications have been evaluated in high-quality studies; therefore, neither therapists nor patients have sufficient evidence to fully rely on such solutions. The characteristics of selected studies on the effects of mobile applications for PFMT in SUI are gathered in Table 1. Further research is required [51, 52].

Table 1. Characteristics of selected studies on the effects of mobile applications for PFMT in SUI

Reference	Main objective	Patients' characteristic	App functions	Study description	Outcome
Asklund et al. 2017 [47]	Assessment of the effectiveness of PFMT with the Tät® mobile app for SUI vs. no treatment	123 women with SUI, min. 1 episode/week, ≥ 6 months 2 groups: intervention group (app group) (n = 62), control group (n = 61)	Data extraction Educational features (information about PFM, SUI, risk factors of SUI) PFMT plan with graphic description for each exercise Reminder Self-monitoring	PFMT 3 × daily for 3 months After 3 months: 2-day leakage diary and web-based questionnaire with follow-up questions on lifestyle, PFMT, symptom severity, and condition-specific quality of life	The app group reported improvements in symptom severity and in the condition-specific quality of life Higher training frequency in intervention group vs. control group (daily training: 41.0% vs. 3.3%; weekly training: 42.6% vs. 13.3%) Patient satisfaction with the app was 'good' or 'very good' in 96.7%
Hoffman et al. 2017 [48]	Evaluation of the long-term effects of using a mobile app to treat SUI with a focus on PFMT	61 women with SUI 2-years after attending PFMT with the Tät® mobile app [47]	As above	Surveys with questions on symptom severity, quality of life, medication, use of local oestrogen therapy, further treatments, and incontinence protection products	The proportion of women who felt they could contract their PFM correctly increased from 30.4% at baseline to 67.4% at follow-up The use of incontinence protection products decreased significantly
Araujo et al. 2020 [49]	Evaluation of the use of a mobile device application (Diário Saúde) for the treatment of UI through adherence to home PFMT and its impact on urinary symptoms	33 women with self-reported SUI symptoms 2 groups: app group (n = 17) (PFMT with the mobile app), control group (n = 16) (PFMT with written instructions)	Dynamic sequence of images on the app screen to follow Music synchronized with the contractions Protocol program to observe adherence Reminder	PFMT 2 × daily for 3 months Evaluation repeated 1, 2, and 3 months after initial evaluation, consisting of: questionnaires assessing urinary symptoms, surface electromyography, and PFM examination with the Modified Oxford Scale	Adherence was higher in the app group 2 and 3 months after PFMT Vaginal symptoms, quality of life, urinary symptoms, and SUI symptoms showed improvement in both groups, with no difference between the groups
Nyström et al. 2022 [50]	Analysis of the factors associated with improvement among app users	2153 women who had completed self-management with the Tät® mobile app	Data extraction Educational features (information about PFM, SUI, risk factors of SUI) PFMT plan with graphic description for each exercise Reminder Self-monitoring	3 months of self-management via the Tät® mobile app After 3 months: follow-up questionnaires about frequency of training over the last 4 weeks, about app usage since downloaded, and about UI symptoms	65.6% of participants reported improvement of UI Improvement was associated with age, frequency of PFMT, and app use

PFM – pelvic floor muscles, PFMT – pelvic floor muscle training, SUI – stress urinary incontinence, UI – urinary incontinence

The lack of validation mechanisms makes it difficult to assess the applications' compliance with medical knowledge, and only the opinions of users provide the basis for evaluating their effectiveness. This may be explained by the fact that the vast majority of applications were developed for commercial purposes [46]. One of such mobile applications, available in the Polish language version, is PelviFly. It is one of the most complex applications, which includes all the features described above. It provides access to a database of information about PFM, training plans, exercise history, and workouts with all the results. The purchase of the full package included direct communication with a selected specialist through the application, as well as the analysis of results and progress. However, there are no data on its effectiveness, independent of those provided by the producer.

Nevertheless, mobile technologies seem to bring benefits in terms of improving UI symptoms, satisfaction, adherence, and lowering the cost of therapy [53].

Conclusions

SUI is a problem that affects many women, reducing their quality of life. Therefore, it is very important to look for optimal therapies with universal access. The effectiveness of training with the use of mobile applications in SUI therapy requires further research, but the reports so far seem promising. However, access to the applications may be hindered to a large extent by the language barrier. To our best knowledge, the number of applications for SUI patients available in the Polish language version is small and there is no verification of their compliance with scientific evidence. There is also a lack of research on the effects of using mobile applications in the field of urogynaecology. Nevertheless, the results of research by foreign authors demonstrate a great potential in this area. It is necessary to involve and cooperate with the scientific community and information technology industry in order to create a reliable, safe tool that could be one of the therapeutic options, widely available. It should be emphasized that training with mobile applications can be a promising supplement to traditional forms of therapy, but it should never replace visiting a health care professional for the correct diagnosis and instructions on how to conduct PFMT because improper exercises may turn out not only ineffective, but also deleterious for the patient's condition.

Ethical approval

The conducted research is not related to either human or animal use.

Disclosure statement

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Conflict of interest

The authors state no conflict of interest.

References

1. Haylen BT, de Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol Urodyn. 2010;29:4–20; doi: 10.1002/nau.20798.
2. Abrams P, Cardozo L, Wagg A, Wein A (eds.). Incontinence, 6th ed. Bristol: International Continence Society; 2017.
3. Shamliyan T, Wyman J, Bliss DZ, Kane RL, Wilt TJ. Prevention of urinary and fecal incontinence in adults. Evid Rep Technol Assess. 2007;161:1–379.
4. Aoki Y, Brown HW, Brubaker L, Cornu JN, Daly JO, Cartwright R. Urinary incontinence in women. Nat Rev Dis Primers. 2017;3:17042; doi: 10.1038/nrdp.2017.42.
5. Hu JS, Pierre EF. Urinary incontinence in women: evaluation and management. Am Fam Physician. 2019;100(6): 339–348.
6. Sangsawang B, Sangsawang N. Stress urinary incontinence in pregnant women: a review of prevalence, pathophysiology, and treatment. Int Urogynecol J. 2013;24(6): 901–912; doi: 10.1007/s00192-013-2061-7.
7. Hillary CJ, Osman N, Chapple C. Considerations in the modern management of stress urinary incontinence resulting from intrinsic sphincter deficiency. World J Urol. 2015;33(9):1251–1256; doi: 10.1007/s00345-015-1599-z.
8. World Health Organization. mHealth: new horizons for health through mobile technologies: based on the findings of the second global survey on eHealth. Geneva: WHO; 2011. Available 10.05.2021 from: http://apps.who.int/iris/bitstream/handle/10665/44607/9789241564250_eng.pdf?sequence=1&isAllowed=y.
9. Office of Electronic Communications. Survey of public opinion on the functioning of the market for telecommunications services and consumer preferences. Report on the individual customer survey [in Polish]. Warszawa, Gdańsk: Office of Electronic Communications; 2019. Available 12.05.2021 from: https://uke.gov.pl/akt/badania-konsumenckie-2019,286.html.
10. Wadensten T, Nyström E, Franzén K, Lindam A, Wastesson E, Samuelsson E. A mobile app for self-management of urgency and mixed urinary incontinence in women: randomized controlled trial. J Med Internet Res. 2021; 23(4):e19439; doi: 10.2196/19439.
11. Lindh A, Sjöström M, Stenlund H, Samuelsson E. Non-face-to-face treatment of stress urinary incontinence: predictors of success after 1 year. Int Urogynecol J. 2016; 27(12):1857–1865; doi: 10.1007/s00192-016-3050-4.
12. Sjöström M, Lindholm L, Samuelsson E. Mobile app for treatment of stress urinary incontinence: a cost-effectiveness analysis. J Med Internet Res. 2017;19(5):e154; doi: 10.2196/jmir.7383.
13. Novara G, Checcucci E, Crestani A, Abrate A, Esperto F, Pavan N, et al. Telehealth in urology: a systematic review of the literature. How much can telemedicine be useful during and after the COVID-19 pandemic? Eur Urol. 2020; 78(6):786–811; doi: 10.1016/j.eururo.2020.06.025.
14. World Health Organization. Adherence to long-term therapies: evidence for action. Geneva: WHO; 2003. Available 10.05.2021 from: https://apps.who.int/iris/handle/10665/42682.
15. Borello-France D, Burgio KL, Goode PS, Markland AD, Kenton K, Balasubramanyam A, et al. Adherence to behavioral interventions for urge incontinence when combined with drug therapy: adherence rates, barriers, and predictors. Phys Ther. 2010;90(10):1493–1505; doi: 10.2522/ptj.20080387.
16. Dumoulin C, Hay-Smith J, Frawley H, McClurg D, Alewijnse D, Bo K, et al. 2014 consensus statement on improving pelvic floor muscle training adherence: International Continence Society 2011 State-of-the-Science Seminar. Neurourol Urodyn. 2015;34(7):600–605; doi: 10.1002/nau.22796.
17. Swift SE, Yoon EA. Test-retest reliability of the cough stress test in the evaluation of urinary incontinence. Obstet Gynecol. 1999;94(1):99–102; doi: 10.1016/s0029-7844(99)00314-2.
18. Laycock J, Jerwood D. Pelvic floor muscle assessment: the PERFECT scheme. Physiotherapy. 2001;87(12):631–642; doi: 10.1016/S0031-9406(05)61108-X.
19. Laycock J, Whelan MM, Dumoulin C. Patient assessment. In: Haslam J, Laycock J (eds.), Therapeutic management of incontinence and pelvic pain: pelvic organ disorders, 2nd ed. London: Springer; 2007; 57–66.
20. Fernandes ACNL, Reis BM, Patrizzi LJ, Meirelles MCCC. Clinical functional evaluation of female's pelvic floor: integrative review. Fisioter Mov. 2018;31:e003124; doi: 10.1590/1980-5918.031.AO24.
21. Lee K. Investigation of electromyographic activity of pelvic floor muscles in different body positions to prevent urinary incontinence. Med Sci Monit. 2019;25:9357–9363; doi: 10.12659/MSM.920819.
22. Navarro Brazález B, Sánchez Sánchez B, Prieto Gómez V, De La Villa Polo P, McLean L, Torres Lacomba M.

Pelvic floor and abdominal muscle responses during hypopressive exercises in women with pelvic floor dysfunction. Neurourol Urodyn. 2020;39(2):793–803; doi: 10.1002/nau.24284.
23. Yoshida M, Murayama R, Hotta K, Higuchi Y, Sanada H. Differences in motor learning of pelvic floor muscle contraction between women with and without stress urinary incontinence: evaluation by transabdominal ultrasonography. Neurourol Urodyn. 2017;36(1):98–103; doi: 10.1002/nau.22867.
24. Rajalakshmi D, Senthil Kumar NS. Strengthening transversus abdominis in pregnancy related pelvic pain: the pressure biofeedback stabilization training. Glob J Health Sci. 2012;4(4):55–61; doi: 10.5539/gjhs.v4n4p55.
25. Opara J, Socha T, Prajsner A, Poświata A. Physiotherapy in stress urinary incontinence in females. Part III. Electrical stimulation in stress urinary incontinence. Fizjoterapia. 2012;20(1):79–86; doi: 10.2478/v10109-012-0010-5.
26. Sheikhhoseini R, Arab AM. Dry needling in myofascial tracks in non-relaxing pelvic floor dysfunction: a case study. J Bodyw Mov Ther. 2018;22(2):337–340; doi: 10.1016/j.jbmt.2017.09.016.
27. Kassolik K, Kurpas D, Andrzejewski W, Wilk I, Swiatek M. The effectiveness of massage in stress urinary incontinence – case study. Rehabil Nurs. 2013;38(6):306–314; doi: 10.1002/rnj.91.
28. Adams SR, Dessie SG, Dodge LE, Mckinney JL, Hacker MR, Elkadry EA. Pelvic floor physical therapy as primary treatment of pelvic floor disorders with urinary urgency and frequency-predominant symptoms. Female Pelvic Med Reconstr Surg. 2015;21(5):252–256; doi: 10.1097/SPV.0000000000000195.
29. Hains G, Hains F, Descarreaux M, Bussières A. Urinary incontinence in women treated by ischemic compression over the bladder area: a pilot study. J Chiropr Med. 2007; 6(4):132–140; doi: 10.1016/j.jcme.2007.10.001.
30. Correia GN, Pereira VS, Hirakawa HS, Driusso P. Effects of surface and intravaginal electrical stimulation in the treatment of women with stress urinary incontinence: randomized controlled trial. Eur J Obstet Gynecol Reprod Biol.2014;173:113–118;doi:10.1016/j.ejogrb.2013.11.023.
31. Pereira VS, Bonioti L, Correia GN, Driusso P. Effects of surface electrical stimulation in older women with stress urinary incontinence: a randomized controlled pilot study [in Spanish]. Actas Urol Esp. 2012;36(8):491–496; doi: 10.1016/j.acuro.2011.11.016.
32. Fürst MCB, de Mendonça RR, Rodrigues AO, de Matos LL, Pompeo ACL, Bezerra CA. Long-term results of a clinical trial comparing isolated vaginal stimulation with combined treatment for women with stress incontinence. Einstein. 2014;12(2):168–174; doi: 10.1590/s1679-4508 2014ao2866.
33. Cardinale M, Bosco C. The use of vibration as an exercise intervention. Exerc Sport Sci Rev. 2003;31(1):3–7; doi: 10.1097/00003677-200301000-00002.
34. Farzinmehr A, Moezy A, Koohpayehzadeh J, Kashanian M. A comparative study of whole body vibration training and pelvic floor muscle training on women's stress urinary incontinence: three-month follow-up. J Family Reprod Health. 2015;9(4):147–154.
35. De Oliveira Guedes-Aguiar E, da Cuncha de Sá-Caputo D, Moreira-Marconi E, de Macêdo Uchôa SM, de Barros PZ, Valentin EK, et al. Effect of whole-body vibration exercise in the pelvic floor muscles of healthy and unhealthy individuals: a narrative review. Transl Androl Urol. 2019; 8(4):395–404; doi: 10.21037/tau.2019.06.14.
36. Yamanishi T, Suzuki T, Sato R, Kaga K, Kaga M, Fuse M. Effects of magnetic stimulation on urodynamic stress incontinence refractory to pelvic floor muscle training in a randomized sham-controlled study. Low Urin Tract Symptoms. 2019;11(1):61–65; doi: 10.1111/luts.12197.
37. Samuels JB, Pezzella A, Berenholz J, Alinsod R. Safety and efficacy of a non-invasive high-intensity focused electromagnetic field (HIFEM) device for treatment of urinary incontinence and enhancement of quality of life. Lasers Surg Med. 2019;51(9):760–766; doi: 10.1002/lsm.23106.
38. He Q, Xiao K, Peng L, Lai J, Li H, Luo D, et al. An effective meta-analysis of magnetic stimulation therapy for urinary incontinence. Sci Rep. 2019;9(1):9077; doi: 10.1038/s41598-019-45330-9.
39. Wang X, Xu X, Luo J, Chen Z, Feng S. Effect of app-based audio guidance pelvic floor muscle training on treatment of stress urinary incontinence in primiparas: a randomized controlled trial. Int J Nurs Stud. 2020;104: 103527; doi: 10.1016/j.ijnurstu.2020.103527.
40. Fitz FF, Gimenez MM, de Azevedo Ferreira L, Matias MMP, Bortolini MAT, Castro RA. Pelvic floor muscle training for female stress urinary incontinence: a randomised control trial comparing home and outpatient training. Int Urogynecol J. 2020;31(5):989–998; doi: 10.1007/s00192-019-04081-x.
41. Bø K, Sherburn M, Allen T. Transabdominal ultrasound measurement of pelvic floor muscle activity when activated directly or via a transversus abdominis muscle contraction. Neurourol Urodyn. 2003;22(6):582–588; doi: 10.1002/nau.10139.
42. Baeßler K, Junginger B. Traditional gymnastic exercises for the pelvic floor often lead to bladder neck descent – a study using perineal ultrasound. Geburtshilfe Frauenheilkd. 2017;77(7):765–770; doi: 10.1055/s-0043-103460.
43. Barton A, Serrao C, Thompson J, Briffa K. Transabdominal ultrasound to assess pelvic floor muscle performance during abdominal curl in exercising women. Int Urogynecol J. 2015;26(12):1789–1795; doi: 10.1007/s00192-015-2791-9.
44. Thompson JA, O'Sullivan PB, Briffa NK, Neumann P. Assessment of voluntary pelvic floor muscle contraction in continent and incontinent women using transperineal ultrasound, manual muscle testing and vaginal squeeze pressure measurements. Int Urogynecol J. 2006;17(6): 624–630; doi: 10.1007/s00192-006-0081-2.
45. Tibaek S, Dehlendorff C. Pelvic floor muscle function in women with pelvic floor dysfunction: a retrospective chart review, 1992–2008. Int Urogynecol J. 2014;25(5):663–669; doi: 10.1007/s00192-013-2277-6.
46. Dantas LO, Carvalho C, de Jesus Santos BL, Ferreira CHJ, Bø K, Driusso P. Mobile health technologies for the management of urinary incontinence: a systematic review of online stores in Brazil. Braz J Phys Ther. 2021;25(4):387–395; doi: 10.1016/j.bjpt.2021.01.001.
47. Asklund I, Nyström E, Sjöström M, Umefjord G, Stenlund H, Samuelsson E. Mobile app for treatment of stress urinary incontinence: a randomized controlled trial. Neurourol Urodyn. 2017;36(5):1369–1376; doi: 10.1002/nau.23116.
48. Hoffman V, Söderström L, Samuelsson E. Self-management of stress urinary incontinence via a mobile app: two-year follow-up of a randomized controlled trial. Acta Obstet Gynecol Scand. 2017;96(10):1180–1187; doi: 10.1111/aogs.13192.

49. Araujo CC, de A Marques A, Juliato CRT. The adherence of home pelvic floor muscles training using a mobile device application for women with urinary incontinence: a randomized controlled trial. Female Pelvic Med Reconstr Surg. 2020;26(11):697–703; doi: 10.1097/SPV.0000000000000670.
50. Nyström E, Söderström L, Samuelsson E. Self-management of incontinence using a free mobile app: factors associated with improvement. Int Urogynecol J. 2022;33:877–885; doi: 10.1007/s00192-021-04755-5.
51. Free C, Phillips G, Galli L, Watson L, Felix L, Edwards P, et al. The effectiveness of mobile-health technology-based health behaviour change or disease management interventions for health care consumers: a systematic review. PLoS Med. 2013;10(1):e1001362; doi: 10.1371/journal.pmed.1001362.
52. Powell AC, Landman AB, Bates DW. In search of a few good apps. JAMA. 2014;311(18):1851–1852; doi: 10.1001/jama.2014.2564.
53. Bernard S, Boucher S, McLean L, Moffet H. Mobile technologies for the conservative self-management of urinary incontinence: a systematic scoping review. Int Urogynecol J. 2020;31(6):1163–1174; doi: 10.1007/s00192-019-04012-w.