INNOVATIVE PHYSIOTHERAPY APPROACHES IN PELVIC FLOOR DYSFUNCTION

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1. INTRODUCTION

The pelvis, which supports the weight of the upper body, is a central structure of the human body situated between the lumbar region of the abdomen above and the thighs below. The pelvic cavity refers to the space enclosed by the pelvic bones. Superiorly, it is continuous with the abdominal cavity, while inferiorly it is bounded by the pelvic floor. This cavity is divided into two regions: the greater pelvis and the lesser pelvis. The greater pelvis, considered a part of the abdominal cavity, is also known as the false pelvis. In contrast, the lesser pelvis belongs to the true pelvic region and is referred to as the true pelvis. Posteriorly, the pelvic cavity is bordered by the sacrum and the coccyx. Functionally, the pelvic cavity serves as a housing space for the urinary bladder, pelvic colon, internal reproductive organs, and the rectum. Additionally, it contains various internal structures and tissues, including muscles, arteries, veins, nerves, and pelvic connective tissue (1). The pelvic floor is a group of muscles that provide support for the organs within the pelvis. It consists of the pelvic diaphragm, which stretches from the pubic symphysis at the front to the coccyx at the back, forming a hammock-like structure that upholds the pelvic organs. The muscles of the pelvic floor include the levator ani group — composed of the puborectalis, pubococcygeus, and iliococcygeus muscles — along with the coccygeus muscle. The levator ani muscles play a crucial role in maintaining pelvic organ support and are innervated by the fourth sacral nerve (2). The pelvic floor structures receive their main nerve supply from the sacral nerves S3 and S4 via the pudendal nerve, and their primary blood supply comes from the parietal branches of the internal iliac artery. The muscles of the pelvic floor support the pelvic organs — including the bladder, urethra, prostate (in males), vagina and uterus (in females), anus, and rectum — as well as the intra-abdominal contents, help maintain urinary and fecal continence, and contribute to sexual functions such as arousal and orgasm (3). The pelvic floor is crucial due to its association with various

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important functions. The pelvic floor, operates in close coordination with the diaphragm and plays an essential role in the respiratory process. During inhalation, both the diaphragm and the PF descend caudally, whereas during exhalation, the diaphragm ascends cephalically as it relaxes, and the pelvic floor contracts. This synchronous movement contributes to maintaining optimal intra-abdominal pressure. Any disruption in the coordination between the diaphragm and the pelvic floor may lead to pressure imbalances, which can consequently cause dysfunctions in other physiological systems, such as impaired peritoneal fluid drainage or reduced postural stability. The pelvic floor is a key component in maintaining postural stability and overall body alignment. Together with core and postural muscles (abdominal, gluteal, and multifidus muscles) the pelvic floor contributes to proper stabilization of the trunk and pelvis. The activity of the pelvic floor is modulated by the tension within these associated core muscles. The proper functioning of the pelvic floor is also influenced by its myofascial connections with the lower extremities. The pelvic floor is linked to the lower limb through fascial continuities involving the gluteal muscles and the internal obturator muscle, both of which regulate hip joint mechanics and lower limb biomechanic. Altered tension or dysfunction in the gluteal region may disturb hip joint mobility, modify mechanical loading patterns, and consequently affect locomotion. Similarly, dysfunctions of the hip joint or lower limb can predispose individuals to pelvic floor -related disorders. The pelvic floor is also integrated with the upper limb complex, cervical spine, and craniofacial structures through fascial connections, including the transversalis, mediastinal, and cervical fascia. Alterations or dysfunctions within this fascial network may manifest as upper limb disorders, diaphragmatic dysfunction, or even parafunctional conditions such as bruxism (4).

Pelvic floor dysfunction (PFD) encompasses a broad spectrum of symptoms, anatomical alterations, and functional disorders resulting from abnormal activity of the pelvic floor muscles. This dysfunction may present as increased muscle tone (hypertonicity), reduced muscle tone (hypotonicity), or impaired coordination of the pelvic floor musculature. Structural changes affecting the support of pelvic organs are also included within this spectrum and are referred to as pelvic organ prolapse (POP). PFD include pelvic organ prolapse, urodynamic stress urinary incontinence, detrusor overactivity, bladder oversensitivity, and voiding dysfunction, as well as associated symptoms such as anal incontinence, dyspareunia, and perineal or pelvic pain (5,6).

Pelvic organ prolapse is a pathological condition characterized by the descent of one or more pelvic organs—including the uterus, bladder, and rectum—from their normal anatomical positions into the vaginal canal, predominantly resulting from the attenuation or failure of the pelvic floor support mechanisms. Although not life-threatening, pelvic organ prolapse can profoundly compromise a patient's quality of life and is frequently associated with considerable psychosocial and functional morbidity (7). Stress urinary incontinence is defined as the involuntary loss of urine through the external urethral orifice that occurs when an increase in intra-abdominal pressure is produced by activities such as sneezing, coughing, or laughing (8). Although not a life-threatening condition, urinary incontinence has been correlated with significant psychosocial consequences, including social withdrawal, anxiety, depressive symptoms, occupational impairment, and sexual dysfunction (9). According to the ICS, detrusor overactivity is defined as "the occurrence of detrusor contraction(s) during filling cystometry". It represents a urodynamic observation characterized by involuntary contractions of the detrusor muscle, which may occur spontaneously or be provoked during bladder filling. These contractions generate waveforms of variable amplitude and duration on the cystometrogram. Epidemiological data indicate that detrusor overactivity is present in approximately 10% of the general population and in nearly 80% of elderly individuals undergoing urodynamic evaluation. Clinically, detrusor overactivity may present with symptoms such as urgency, frequency, and urge urinary incontinence, resulting in a substantial deterioration of the affected individuals' quality of life (10). According to the ICS, bladder oversensitivity is defined as an increased perception of bladder sensation during the filling phase, characterized by an early desire to void in the absence of any corresponding rise in detrusor pressure on cystometric evaluation (11). The ICS defines female voiding dysfunction as abnormally slow and/or incomplete bladder emptying, characterized by reduced urinary flow rates and/or elevated post-void residual volumes, preferably confirmed through repeated measurements to ensure diagnostic accuracy (12). Anal incontinence is defined as the involuntary loss of fecal matter or flatus, resulting from a failure of the normal mechanisms responsible for maintaining continence (13). Dyspareunia is defined as genital pain occurring before, during, or after penile–vaginal sexual intercourse (14). Pelvic pain is defined as pain localized to the lower abdominal region below the umbilicus, encompassing the pelvis, pelvic organs, and genital structures. It is associated with a substantial individual burden, including diminished physical functioning, adverse psychological outcomes, reduced social engagement, impaired sexual function, and negative effects on occupational performance (15).

2. ASSESSMENT METHODS IN PELVIC FLOOR DYSFUNCTION

Various methods (including clinical examination techniques, imaging methods, functional tests, questionnaires and self-report measurement tools, and current technologies) are used in the assessment of pelvic floor dysfunction. These approaches enable accurate evaluation of patients' symptoms and facilitate the development of an appropriate treatment plan (16).

2.1. Clinical Assessment Method

2.1.1. Digital Palpation Method

With the digital palpation method, pelvic floor muscle contraction is assessed through a vaginal examination. The individual squeezes the index and middle fingers placed inside the vagina. The strength of the contraction is generally evaluated using the Modified Oxford Scale (MOS). According to this scale: 0 = no contraction, 1 = flicker/tremor, 2 = weak, 3 = moderate, 4 = good, 5 = strong contraction (16). In addition to muscle strength, other parameters such as power, endurance, repetitions, fast contractions, and timing of each contraction can be standardized using the PERFECT scheme. This method is frequently used, particularly in women, to quickly screen pelvic floor muscle function and to teach exercises (17). Digital vaginal examination is practical and economical since it requires no equipment; it also allows direct feedback from the clinician or physiotherapist. When performed correctly, it demonstrates good reproducibility among experienced evaluators and provides patients with the opportunity to learn correct muscle activation. However, it is a subjective method and depends on the evaluator. Its reliability is limited when not performed by experienced practitioners (18,19).

2.2. Pelvic Organ Prolapse Quantification System (POP-Q)

The Pelvic Organ Prolapse Quantification System (POP-Q) is an internationally standardized method used to determine the severity of pelvic organ prolapse (13). During vaginal examination, nine anatomical reference points are evaluated, and the degree of prolapse is classified into stages 0 to 4. According to the standardized POP-Q assessment, Stage 0 indicates the absence of prolapse; Stage 1 refers to a prolapse point located more than 1 cm above the hymen; Stage 2 indicates the prolapse point lies within ±1 cm of the hymenal plane, either inside or outside; Stage 3 is defined as the most distal prolapse point being more than 1 cm below the hymen but less than 2 cm short of the total vaginal length; and Stage 4 represents complete prolapse, in which the vagina is entirely descended outside (20).

2.3. Ultrasonography (USG)

Translabial/transperineal 2D and 3D/4D ultrasonography enables dynamic imaging of pelvic floor structures. Bladder neck mobility, bladder wall thickness, urethral integrity, pelvic compartment prolapses, and levator ani anatomy/function can be examined using this method (15). Ultrasonography is a non-invasive, well-tolerated, and repeatable technique. As it provides real-time images, organ movement can be observed instantly during patient manoeuvres such as straining, coughing, or contracting. With 3D/4D ultrasound technology, the levator muscle complex, urethra, bladder, and rectum can be visualised simultaneously (16). Artificial intelligence-supported analysis algorithms enable automatic measurements such as levator ani muscle and hiatus segmentation, thereby reducing operator dependency and increasing the reproducibility and reliability of the assessment (17). Furthermore, technologies such as tactile imaging can be used to obtain a three-dimensional map of the pressure distribution in pelvic floor tissues and to quantify tissue elasticity (18).

2.4. Magnetic Resonance Imaging (MRI)

Magnetic Resonance Imaging is a method that allows for detailed assessment of the contrast resolution of soft tissues. Dynamic MRI defecography is particularly preferred for the assessment of posterior compartment prolapse and defecation disorders. Radiation-free multiplanar images can be obtained, allowing all pelvic compartments to be evaluated simultaneously (19).

2.5. Defecography

Defecography is a traditional method, particularly for evaluating posterior compartment (rectum and anal canal) dysfunction. Classically, a barium contrast medium is administered into the patient's rectum, and the defecation act is imaged under fluoroscopy on a special toilet chair. During this procedure, which is recorded on video, pathologies such as rectocele (rectal wall hernia), rectal prolapse, rectal intussusception (inward folding of the rectum), and paradoxical contraction of the puborectalis muscle (anismus) can be detected (20).

2.6. Mobile Applications and Sensor-Equipped Devices

Mobile health solutions that facilitate remote assessment are becoming increasingly widespread. For example, many mobile applications guide women through pelvic floor exercises, while others provide real-time biofeedback through integrated sensors (e.g., pressure probes, accelerometers) (21).

2.7. Questionnaires

In assessing pelvic floor dysfunction, it is crucial to understand patients' symptoms and the impact of these symptoms on their quality of life. Objective measurements alone may not reflect the severity of the discomfort experienced by the patient. Therefore, standard questionnaire forms and scales based on patient self-report have been developed. The Pelvic Floor Distress Inventory (PFDI-20), Pelvic Floor Impact Questionnaire (PFIQ-7) and International Consultation on Incontinence Questionnaires (ICIQ) are prominent examples. The PFDI-20 determines symptom burden by assessing urinary incontinence (UDI-6), prolapse (POPDI-6) and anorectal symptoms (CRADI-8) through its 20-item structure. The PFIQ-7, on the other hand, assesses the impact of pelvic floor disorders on daily life and emotional health, focusing on the quality of life dimension. ICIQ forms (particularly the ICIQ-UI short form) standardise the assessment of urinary incontinence frequency, volume, and impact on quality of life; they also have subtypes for overactive bladder (ICIQ-OAB) and vaginal symptoms (ICIQ-VS) (22). For urinary/faecal incontinence, the short form questionnaires of the International Continence Advisory Committee (ICIQ) are preferred (23).

3. INNOVATIVE PHYSIOTHERAPY APPROACHES

In pelvic floor rehabilitation, alongside traditional approaches (such as pelvic floor muscle training, manual therapy techniques, behavioural and lifestyle changes, and functional exercise training), technology-assisted innovative treatment methods have gained increasing importance in recent years. Methods such as virtual reality applications, biofeedback, and tele-rehabilitation applications have been developed or adapted to existing systems to increase patient participation and motivation and, in some cases, to provide remote access (24).

3.1. Pelvic floor muscle training (PFMT)

Pelvic floor muscle training programmes aim to strengthen the core pelvic floor muscles, increase their endurance, and enable them to contract at the right time. The most well-known PFMT is the Kegel exercise. It has been reported that women who performed PFMT achieved a higher rate of urinary control and a significant reduction in symptom severity compared to the control group (25).

According to the NICE guidelines, PFMT is recommended for at least 4 months for pelvic organ prolapse and at least 3 months for faecal incontinence, while the AUA guidelines also indicate PFMT (with or without biofeedback) as a low-risk first-line treatment option (26,27). Patient adherence is important. A study that followed women with stress incontinence for 15 years reported that only 28% continued with weekly exercises (28). PFMT is non-invasive, safe, and low-cost. It improves symptom control by increasing pelvic floor muscle strength and endurance. However, since targeting the correct muscle groups is critical for treatment effectiveness, it is essential that the programme be performed under specialist supervision.

3.1.1 Fundamental Mechanisms for PFMT

Increasing muscle strength: Through repeated contractions, the thickness and strength of the pelvic floor muscles are enhanced, thereby strengthening the area around the urethra and rectum. The levator ani muscle is specifically targeted.

Timing awareness: Training the patient to reflexively contract the pelvic floor muscles during moments of strain. This strategy ensures urethral closure during increases in intra-abdominal pressure.

Core muscle training: Strengthening the core muscles (particularly the m. transversus abdominis) facilitates the reflexive co-contraction of the pelvic floor muscles. This promotes overall body stabilisation and provides additional support to the pelvic floor (25).

3.2. Virtual Reality-Assisted Rehabilitation Applications

Virtual reality environments are simulated environments designed in three dimensions using computer hardware, which give the user the feeling of being present in that environment and appeal to interactive and sensory inputs. In recent years, the use of virtual reality in healthcare and physiotherapy has been increasing, offering significant innovations in the rehabilitation process (29,30). Virtual reality enables movements to be performed in a goal-oriented, intensive, repetitive, and enjoyable manner by providing visual feedback and is particularly preferred in chronic, long-term rehabilitation processes (31,32).

Additionally, VR ensures that patients participate in treatment with greater motivation and makes the rehabilitation process more engaging. However, there are also some disadvantages. Side effects such as dizziness, nausea, and blurred vision may occur during virtual reality applications. High costs and difficulties in accessing equipment also limit the widespread use of VR. Moreover, the effects of long-term use are not yet fully understood, creating uncertainty regarding potential risks (33).

The use of virtual reality applications in pelvic floor rehabilitation is becoming increasingly widespread. In VR-based treatments, patients exercise their pelvic floor muscles by performing movements in a simulated environment using VR goggles or a screen. According to studies, VR games have been shown to improve pelvic floor muscle strength and patients' quality of life (34).

In a randomised controlled trial, Lin et al. (2022) compared the effectiveness of pelvic movement training in medical students using traditional methods versus a VR-supported Wii Fit application. A total of forty-four students without prior pelvic movement training were randomly assigned to two groups. The control group received only conventional lessons, whereas the experimental group attended additional VR-supported sessions alongside the traditional curriculum. Both groups exhibited significant gains in knowledge and practical skills following the training. However, while performance in written examinations was comparable, the VR group achieved markedly higher scores in practical assessments. At the two-week follow-up, knowledge levels were maintained, whereas a partial decline in practical skills was noted. The vast majority of students reported that VR facilitated learning, was motivating, and enjoyable. This study highlights that VR can make a valuable contribution to traditional education, particularly in enhancing practical skills and increasing student motivation (35).

A randomised controlled trial examining the effect of VR-assisted pelvic floor exercises on urinary incontinence demonstrated that an 8-week VR-assisted exercise programme improved pelvic floor muscle function and quality of life, but this improvement was not statistically different from that of a traditional exercise programme (34). Back pain and pelvic pain during pregnancy are common problems affecting approximately 50% of women. In a study conducted in the Spanish cities of Seville and Malaga, 66 pregnant women (in the 2nd and 3rd trimesters, with a pain VAS score ≥4) were included in a physiotherapy programme consisting of 3 sessions per week for 4 weeks. The control group received a standard physiotherapy programme (daily health checks, thermotherapy, TENS, therapeutic massage and breathing, thoracic, lumbar and pelvic mobilisation, breathing and stretching exercises), the experimental group received virtual reality breathing exercises and free movement and relaxation exercises in a virtual nature setting in addition to standard physiotherapy. The study suggests that VR technology can reduce pain perception through its distracting effect, improve psychological well-being by promoting relaxation, and enhance compliance with physiotherapy (14).

3.3. The Role of Telerehabilitation in Pelvic Floor Dysfunction (Remote Rehabilitation)

Telemedicine is defined as the application of information and communication technologies by healthcare professionals to support the diagnosis, management, and prevention of diseases and injuries, to facilitate the exchange of health-related information, to conduct research and evaluation, to provide training for healthcare providers, and to enhance both individual and community health (36).

In pelvic floor dysfunction, tele-rehabilitation services can enable patients to undergo treatment at home via online platforms with the guidance of physiotherapists. This service can provide access for women living in rural or remote areas who are reluctant to visit the clinic due to urogenital problems or who have difficulty accessing pelvic floor rehabilitation services.

The 6-month results of online group-based pelvic floor muscle training in women over 65 years of age were evaluated. Improvements were maintained after the 12-week programme, urinary incontinence decreased by 73%, and quality of life and self-efficacy increased. Most participants adhered to the exercises and reported high satisfaction. The findings indicate that telerehabilitation is effective and sustainable in the treatment of urinary incontinence in older women (37).

Of the 34 women aged 65 and over with urinary incontinence who participated in the online group-based pelvic floor muscle training programme, 33 completed the programme, demonstrating a high retention rate (97%). The majority of participants (72%) were completely satisfied with the treatment outcomes, 25% were partially satisfied, and only one woman (3%) reported dissatisfaction. The results indicated that online group-based PFMT is a feasible, safe, and effective alternative for both participants and clinicians (38).

In a study conducted by Santiago and colleagues, women who underwent pelvic floor muscle training online at home were compared with women who received face-to-face training at a clinic. The study found that both groups showed significant improvements in quality of life, symptom severity, pad test, and daily pad usage. However, there was no significant difference in the magnitude of improvement between the groups. Both groups adhered to home exercises and sessions at a high rate, with satisfaction levels reported as an average of 9/10. Improvements were also seen in sexual function and anxiety-depression scores, but no differences were found between the groups (39). This research suggest that remote training can be at least as effective as traditional methods. Therefore, it is an attractive option for patients who cannot find the time to come to the clinic or who have barriers to access. In conclusion, telerehabilitation has emerged as an innovative and powerful tool in pelvic floor physiotherapy. With the widespread adoption of this approach, particularly in the long term, more patients will be able to access conservative treatments, clinical outcomes will improve, and there may be cost-saving benefits for the healthcare system.

3.4. Electrotherapy

Electrotherapy methods (Functional Electrical Stimulation (FES), Neuromuscular Electrical Stimulation (NMES), Transcutaneous Electrical Nerve Stimulation (TENS) aim to alleviate incontinence and overactive bladder symptoms by activating the pelvic floor muscles and related nerves through electrical stimulation.

FES/NMES: These approaches, typically delivered via vaginal or rectal probes, aim to treat stress and mixed incontinence by directly activating the pelvic muscles. In a meta-analysis by Huang et al. (2024), combining FES/NMES with pelvic floor exercises significantly reduced the severity of pelvic floor dysfunction and increased muscle strength but did not significantly change quality of life (40).

Transcutaneous Nerve Stimulation: A systematic review indicates that transcutaneous nerve stimulation applied via the tibial or sacral nerve is effective in improving overactive bladder symptoms (41).

3.5. Behavioural Changes and Lifestyle Modifications

Bladder training is the first-line treatment for pelvic floor dysfunction. A 6-week plan to reduce toilet frequency (e.g., gradually increasing the interval between urination) is recommended. Keeping a voiding diary, recording urine volumes and times, is beneficial during this process. The following general recommendations are given regarding fluid intake, diet, and toilet habits during bladder training:

Diet and Fluid Management: The type and amount of daily beverages affect symptoms. Caffeine intake (coffee, tea, cola drinks) can particularly increase irritable bladder symptoms. A 2023 systematic review reported that caffeine restriction reduced urgency, voiding frequency, and nocturia; conversely, high fluid intake worsened symptoms. Participants who restricted caffeine showed significant improvement in urinary urgency and incontinence episodes (42).

Weight Control: Systematic reviews have shown that weight loss significantly reduces incontinence symptoms. In their meta-analysis, Sheridan et al. (2021) noted that weight loss initiatives reduced the risk of incontinence in women and decreased the prevalence of both stress incontinence and urge incontinence (43).

Smoking Cessation: Smoking increases the risk of stress incontinence through chronic coughing and may worsen overactive bladder symptoms through its vascular effects. Studies show that women who smoke have significantly higher overactive bladder and incontinence scores than non-smokers (44). A study conducted on young adults showed a marked improvement in urinary frequency after quitting smoking (45).

4. CONCLUSION

Traditional approaches for evaluating and managing pelvic floor dysfunction include clinical examination; imaging modalities such as ultrasound, MRI, and defecography; objective techniques like perineometry and electromyography; as well as standardized questionnaires. However, innovative methods such as artificial intelligence-based analyses, virtual reality applications, mobile health solutions, and tele-rehabilitation are now coming to the fore. These modern approaches increase patient compliance, facilitate accessibility, and contribute to the individualisation of treatment processes. Therefore, current approaches demonstrate that a multidisciplinary, technological, and evidence-based perspective is becoming increasingly important in the management of pelvic floor dysfunctions.

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