ULTRASONOGRAPHY AS A BIOFEEDBACK TOOL IN PELVIC FLOOR REHABILITATION

Inna Ivanova
Medical University Sofia, Faculty of Public Health "Prof. Tzecomir Vodenitcharov, MD, DSc", Department "Physiotherapy", Bulgaria, inna_mincheva@abv.bg
Elvira Nikovska
Medical University Sofia, Faculty of Public Health "Prof. Tzecomir Vodenitcharov, MD, DSc", Department "Physiotherapy", Bulgaria, e.nikovska@gmail.com
Stefan Yanev
Medical University Sofia, Faculty of Public Health "Prof. Tzecomir Vodenitcharov, MD, DSc", Department "Physiotherapy", Bulgaria, s.janev@foz.mu-sofia.bg
Vanina Mihaylova
Medical University Sofia, Faculty of Public Health "Prof. Tzecomir Vodenitcharov, MD, DSc", Department "Physiotherapy", Bulgaria, v.mihailova@foz.mu-sofia.bg
Todor Dimitrov
Medical University Sofia, Faculty of Public Health "Prof. Tzecomir Vodenitcharov, MD, DSc", Department "Physiotherapy", Bulgaria, t.dimitrov@foz.mu-sofia.bg

Abstract: Pelvic floor dysfunctions represent a significant health problem affecting a large portion of the population, particularly women during the postpartum period and in older age. The pelvic floor muscles play a crucial role in maintaining continence, ensuring lumbopelvic stability, and supporting the normal function of the pelvic organs. Impairments in their function may result in various clinical manifestations, including urinary and fecal incontinence, pelvic organ prolapse, chronic pelvic pain, and sexual dysfunction, which significantly reduce the quality of life and social participation of affected individuals. Pelvic floor rehabilitation is increasingly recognized as an effective and safe conservative therapeutic approach aimed at improving muscle strength, coordination, and functional control of the pelvic musculature. An important component of this process is the use of different forms of biofeedback, which assist patients in learning how to properly activate and control their pelvic floor muscles. In recent years, ultrasonography has increasingly been used as a visual biofeedback tool in pelvic floor therapy. Ultrasound imaging allows real-time visualization of the movement and activity of the pelvic floor muscles and surrounding anatomical structures, facilitating patient education during rehabilitation. This method provides patients with immediate visual feedback on the correct performance of exercises, which may enhance the effectiveness of therapy and facilitate the restoration of normal muscle function. Despite the growing interest in this method and its demonstrated benefits in clinical practice, significant differences exist in regulatory frameworks between countries regarding the use of ultrasound equipment by physiotherapists. Aim: The aim of the present study is to analyze the role of ultrasound as a biofeedback tool in pelvic floor therapy and to discuss the possibilities and limitations of its application in contemporary physiotherapy practice. Methods: A literature review was conducted through an analysis of scientific publications indexed in databases such as Scopus, Web of Science, and Google Scholar. Results: Ultrasound provides real-time visualization of the pelvic floor muscles and surrounding structures, allowing objective assessment of muscle activity and supporting patient education for correct pelvic muscle activation. The use of ultrasound biofeedback facilitates the therapeutic process, improves control of muscle contractions, and may enhance the effectiveness of rehabilitation programs. Conclusion: Ultrasound biofeedback represents a valuable tool in modern pelvic floor therapy, as its application may improve patient education, optimize the rehabilitation process, and contribute to better clinical outcomes in individuals with pelvic floor dysfunctions. However, differences in regulatory frameworks between countries remain regarding the use of ultrasound equipment by physiotherapists. In some countries, the right to use ultrasound is mainly restricted to physicians, which may represent a barrier to the broader implementation of ultrasound biofeedback in physiotherapy practice.
Keywords: pelvic floor, biofeedback, ultrasonography, rehabilitation.

1. INTRODUCTION

Pelvic floor muscles constitute an essential component of the functional stabilizing system of the human body, playing a key role in supporting the pelvic organs, maintaining continence, and ensuring the stability of the lumbopelvic complex. They actively participate in the regulation of intra-abdominal pressure and function in coordination with the diaphragm, the abdominal musculature, and the deep back muscles. Due to this complex

functional interaction, impairments in pelvic floor function may lead to a range of clinical conditions that significantly affect patients' health and quality of life.

Pelvic floor dysfunctions represent a significant health problem affecting a large portion of the population, particularly women in the postpartum period and in older age. Impairments in pelvic floor muscle function may lead to various clinical manifestations, including urinary and fecal incontinence, pelvic organ prolapse, chronic pelvic pain, and sexual dysfunction. These conditions often result in reduced physical activity, social isolation, and a significant decline in quality of life.

Over the past decades, conservative therapeutic approaches for the treatment of pelvic floor dysfunctions have developed considerably. Pelvic floor rehabilitation has become established as an effective and safe method aimed at improving the strength, endurance, and coordination of the pelvic musculature. A key component of this process is training patients to properly activate the pelvic floor muscles, which is often supported through various forms of biofeedback. Biofeedback provides information about muscle activity and helps patients better understand and control muscle contractions during therapeutic exercises.

In recent years, ultrasound has increasingly been used as a visual biofeedback tool in pelvic floor rehabilitation. Ultrasound imaging allows real-time observation of the movement and activity of the pelvic floor musculature and adjacent anatomical structures, facilitating patient education and supporting more precise control during exercise performance. In this way, ultrasound may contribute to improving the effectiveness of rehabilitation programs and enhancing functional outcomes in patients with pelvic floor dysfunction.

Despite the growing interest in the use of ultrasound as a biofeedback tool, significant differences exist in regulatory frameworks across countries regarding the use of ultrasound equipment by physiotherapists. In some countries, the right to use ultrasound is primarily restricted to physicians, which creates several professional and practical challenges for the broader implementation of ultrasound biofeedback in physiotherapy practice. This raises an important question regarding the role of this method in contemporary rehabilitation and highlights the need for clearly defined professional competencies in its application.

In this context, the present study aims to analyze the role of ultrasound as a biofeedback tool in pelvic floor therapy and to examine the possibilities and limitations of its application in modern physiotherapy practice.

2. MATERIALS AND METHODS

The present study represents a literature review aimed at analyzing scientific publications addressing the application of ultrasound as a biofeedback tool in pelvic floor rehabilitation.

The literature search was conducted in the electronic databases **Scopus, Web of Science, and Google Scholar.** To identify relevant publications, combinations of English-language keywords were used, including *pelvic floor*, *pelvic floor muscle training*, *biofeedback*, *ultrasound*, *rehabilitative ultrasound imaging (RUSI)*, and *pelvic floor rehabilitation*. Boolean operators **AND** and **OR** were applied to refine and optimize the search results.

The analysis included scientific publications that met the following criteria: articles published in peer-reviewed scientific journals; studies examining the application of ultrasound as a biofeedback tool or as an instrument in rehabilitation practice; publications related to pelvic floor physiotherapy and pelvic floor muscle training.

Publications focusing exclusively on the diagnostic applications of ultrasound without relevance to rehabilitation were excluded, as well as articles that did not provide sufficient information regarding the use of ultrasound as a biofeedback tool.

The identified publications were initially screened based on their titles and abstracts, followed by a detailed analysis of the full texts of the relevant sources. The collected information was used to systematize the current scientific evidence regarding the role of ultrasound as a visual biofeedback tool in pelvic floor rehabilitation.

3. RESULTS

The analysis of the included scientific publications indicates that ultrasound represents an effective tool for visual biofeedback in pelvic floor rehabilitation. Systematic reviews show that ultrasound imaging is increasingly used as a visual biofeedback method, as it facilitates the observation of muscle activity and supports patient training for proper activation of the pelvic floor musculature (Valera-Calero et al., 2021). Recent studies also emphasize that technological approaches for assessing pelvic floor function, including ultrasound imaging, provide new opportunities both for the objective evaluation of muscle activity and for supporting the rehabilitation process (Förstl et al., 2024). Through real-time visualization of the movement and activity of the pelvic floor musculature and adjacent anatomical structures, ultrasound imaging facilitates patient education and supports the acquisition of proper movement patterns during rehabilitation (Thompson et al., 2006).

Studies indicate that the use of ultrasound biofeedback improves patients' understanding of the mechanism of muscle contraction and supports the acquisition of proper technique during pelvic floor rehabilitation exercises.

Real-time visual feedback contributes to better control of muscle activity and facilitates the correction of improper movement patterns. Furthermore, transperineal ultrasound imaging allows for the quantitative assessment of pelvic floor movements and provides objective information on muscle function during exercise (Stafford et al., 2012).

Available evidence suggests that the inclusion of ultrasound as a biofeedback tool may enhance the effectiveness of pelvic floor muscle training. Systematic reviews indicate that pelvic floor muscle training combined with biofeedback or feedback from a physiotherapist can improve control of muscle function and contribute to the reduction of symptoms of urinary and anal incontinence after childbirth (Höder et al., 2023). Similar findings have been reported in more recent clinical studies, showing that combining patient education with biofeedback therapy may lead to significant improvements in pelvic floor muscle function (Yuan et al., 2024).

This approach supports improvements in muscle coordination and functional control, which may contribute to better therapeutic outcomes in patients with urinary incontinence and other forms of pelvic floor dysfunction (Dumoulin et al., 2014; Bø & Hilde, 2013). Furthermore, it has been demonstrated that the pelvic floor muscles function in coordination with the diaphragm and abdominal musculature in the regulation of intra-abdominal pressure, which plays an important role in the stability of the lumbopelvic complex (Hodges & Gandevia, 2000). Additional studies have shown that the pelvic and abdominal musculature are co-activated during voluntary exercises, highlighting the importance of integrated muscular control in the stabilization of the lumbopelvic segment (Sapsford et al., 2001). This interaction is essential for the development of effective rehabilitation programs.

Furthermore, ultrasound imaging is increasingly used in rehabilitation medicine as part of the concept of **Rehabilitative Ultrasound Imaging (RUSI),** which provides the possibility for objective assessment of muscle function and supports the therapeutic process through visual biofeedback (Whittaker et al., 2007). Several authors have indicated that RUSI has the potential to become an important tool in rehabilitation practice, as it provides more precise information on muscle activity and supports clinical decision-making in the treatment of musculoskeletal and pelvic floor disorders (Teyhen, 2011). More recent studies also highlight the role of ultrasound imaging as a valuable tool for the assessment and support of pelvic floor rehabilitation, as it enables more accurate monitoring of muscle activity and therapeutic progress (Kołodyńska et al., 2025).

4. DISCUSSIONS

The obtained results indicate that ultrasound has significant potential as a visual biofeedback tool in pelvic floor rehabilitation. Real-time observation of the movement and activity of the pelvic musculature allows for a better understanding of the mechanism of muscle contraction and supports patient training for proper activation of the pelvic floor muscles. These findings are consistent with existing scientific evidence demonstrating that ultrasound imaging can assist both in the assessment of muscle function and in patient training during the rehabilitation process (Valera-Calero et al., 2021; Thompson et al., 2006).

Within the context of current knowledge on pelvic floor rehabilitation, the use of visual biofeedback plays an important role in improving the effectiveness of pelvic floor muscle training. Many patients experience difficulty in correctly activating the pelvic musculature without external feedback. In this regard, ultrasound imaging provides valuable information about muscle activity and enhances patients' awareness of muscle function, facilitating the acquisition of proper movement patterns. This is particularly important for patients with urinary or anal incontinence, in whom correct muscle contraction technique is a key factor for successful rehabilitation (Höder et al., 2023; Yuan et al., 2024).

Furthermore, the results of the present analysis indicate that integrating ultrasound into rehabilitation programs may contribute to improving muscle coordination and functional control of the pelvic floor. This is consistent with findings from systematic reviews confirming the effectiveness of pelvic floor muscle training as a conservative treatment for urinary incontinence and other forms of pelvic floor dysfunction (Dumoulin et al., 2014; Bø & Hilde, 2013). In addition, the interaction between the pelvic floor muscles, the diaphragm, and the abdominal musculature plays an important role in the stability of the lumbopelvic complex and in the regulation of intra-abdominal pressure (Hodges & Gandevia, 2000; Sapsford et al., 2001). These functional relationships highlight the importance of an integrated approach in the rehabilitation of pelvic floor dysfunctions.

Another important aspect addressed in the present review is the role of ultrasound imaging as part of the concept of Rehabilitative Ultrasound Imaging (RUSI). This approach enables objective observation of muscle function and supports the therapeutic process through visual biofeedback. Several authors emphasize that RUSI may become an important tool in rehabilitation practice, as it supports clinical decision-making and allows more precise monitoring of therapeutic progress (Whittaker et al., 2007; Teyhen, 2011). More recent studies also highlight the potential of ultrasound imaging to improve the assessment of muscle activity and to optimize rehabilitation interventions in patients with pelvic floor dysfunction (Kołodyńska et al., 2025).

Despite these advantages, several limitations remain, mainly related to differences in regulatory frameworks across countries regarding the use of ultrasound equipment by physiotherapists. In many countries, the use of ultrasound is primarily restricted to physicians, which may hinder the broader implementation of ultrasound biofeedback in physiotherapy practice. This highlights the need for clearer definitions of professional competencies and for the development of standardized guidelines regarding the use of ultrasound as part of the rehabilitation process.

In summary, the results of the present study indicate that ultrasound has the potential to become a valuable tool for visual biofeedback in pelvic floor rehabilitation. The integration of this method into clinical practice may support more precise patient training and enhance the effectiveness of rehabilitation interventions. At the same time, further research is needed to clarify the optimal approaches for the application of ultrasound and to facilitate its broader implementation in contemporary physiotherapy practice.

5. CONCLUSIONS

The present literature review demonstrates that ultrasound has considerable potential as a visual biofeedback tool in pelvic floor rehabilitation. Real-time ultrasound imaging enables a better understanding of pelvic floor muscle function and supports patient training for proper activation and control of the pelvic floor muscles. In this way, it may contribute to improving the effectiveness of pelvic floor muscle training and enhancing functional outcomes in patients with pelvic floor dysfunction.

The results of the analysis confirm that integrating ultrasound as a biofeedback tool into rehabilitation programs may facilitate more precise patient training, improve control of muscle contractions, and support the individualization of therapeutic interventions. This expands the possibilities of contemporary physiotherapy practice and creates conditions for more effective management of various forms of pelvic floor dysfunction.

At the same time, differences exist in regulatory frameworks across countries regarding the use of ultrasound equipment by physiotherapists. In some countries, the right to use ultrasound is primarily restricted to physicians, which may represent a barrier to the broader application of ultrasound biofeedback in physiotherapy practice. This highlights the need for clearer definitions of professional competencies and the development of standardized guidelines for the use of ultrasound in pelvic floor rehabilitation.

Further research is required to more comprehensively evaluate the effectiveness of ultrasound biofeedback and to determine its role in the comprehensive treatment of pelvic floor dysfunctions, as well as to support its broader implementation in clinical physiotherapy practice.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the colleagues from the Department of Physiotherapy at the Faculty of Public Health “Prof. Tzecomir Vodenitcharov, MD, DSc”, Medical University – Sofia, for their support and valuable professional guidance during the preparation of the present study.

REFERENCES

Bø, K., & Hilde, G. (2013). Does it work in the long term? A systematic review on pelvic floor muscle training for female stress urinary incontinence. *Neurourology and Urodynamics, 32*(3), 215–223.

Dumoulin, C., Hay-Smith, J., & Mac Habée-Séguin, G. (2014). Pelvic floor muscle training versus no treatment for urinary incontinence in women. *Cochrane Database of Systematic Reviews*, (5), CD005654.

Förstl, N., et al. (2024). Technologies for evaluation of pelvic floor functionality: A systematic review. *Sensors, 24*(12), 4001.

Hodges, P. W., & Gandevia, S. C. (2000). Changes in intra-abdominal pressure during postural and respiratory activation of the human diaphragm. *Journal of Applied Physiology, 89*(3), 967–976.

Höder, A., Stüpp, L., & Resende, A. P. M. (2023). Pelvic floor muscle training with physiotherapist feedback or biofeedback: A systematic review. *BMC Women’s Health, 23*, 628. https://doi.org/10.1186/s12905-023-02765-7

Kołodyńska, G., et al. (2025). Assessment of the possibility of using ultrasound imaging in pelvic floor rehabilitation. *Bioengineering*.

Sapsford, R., Hodges, P., Richardson, C., Cooper, D., Markwell, S., & Jull, G. (2001). Co-activation of the abdominal and pelvic floor muscles during voluntary exercises. *Neurourology and Urodynamics, 20*(1), 31–42.

Stafford, R. E., Ashton-Miller, J. A., Constantinou, C. E., & Hodges, P. W. (2012). Quantifying pelvic floor displacement from transperineal ultrasound images. *Neurourology and Urodynamics, 31*(6), 947–953.

Thompson, J. A., O’Sullivan, P. B., Briffa, N. K., & Neumann, P. (2006). Assessment of pelvic floor movement using transabdominal and transperineal ultrasound. *Neurourology and Urodynamics, 25*(4), 301–308.

Teyhen, D. S. (2011). Rehabilitative ultrasound imaging: The roadmap ahead. *Journal of Orthopaedic & Sports Physical Therapy, 41*(11), 819–823.

Valera-Calero, J. A., Ojedo-Martín, C., & Fernández-de-Las-Peñas, C. (2021). Ultrasound imaging as a visual biofeedback tool in rehabilitation: A systematic review. *International Journal of Environmental Research and Public Health, 18*(14), 7554. https://doi.org/10.3390/ijerph18147554

Whittaker, J. L., Teyhen, D. S., Elliott, J. M., Cook, K., Langevin, H. M., Dahl, H. H., & Stokes, M. (2007). Rehabilitative ultrasound imaging: Understanding the technology and its applications. *Journal of Orthopaedic & Sports Physical Therapy, 37*(8), 434–449.

Yuan, F., et al. (2024). Effect of health education combined with biofeedback therapy on pelvic floor muscle function. *Journal of Clinical Medicine*.