BAU HEALTH AND INNOVATION

Doi: 10.14744/bauh.2025.47966

BAU Health Innov 2024;2(3):125–133

Review

The Co-contraction Relationship Between Pelvic Floor Contraction and Transversus Abdominis: A Traditional Review

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Abstract

The simultaneous activation of the pelvic floor muscles (PFM) and transversus abdominis (TrA) plays a critical role in maintaining pelvic stability and postural control. Pelvic dysfunctions such as urinary incontinence and chronic pelvic pain can significantly reduce individuals' quality of life, while the coordinated activation of these two muscle groups has emerged as an effective approach to managing such symptoms. This review evaluates the physiological and clinical effects of the combined activity of the PFM and TrA by examining studies on various exercise approaches and methods. *Hypopressive exercises* (HE) and *dynamic neuromuscular stabilization* (DNS) techniques have been shown to support pelvic stability, enhance muscle endurance, and improve postural control. The effects of exercises performed in supine and sitting positions on muscle activation may facilitate the development of personalized physical therapy programs. Supported by objective measurement methods such as ultrasound and electromyography, these studies demonstrate that the synchronized activation of the PFM and TrA plays a crucial role in the prevention and treatment of pelvic dysfunctions. By integrating different approaches, this review provides a comprehensive evaluation of the clinical applications of the pelvic floor (PF) and TrA muscles.

Keywords: Co-activation, hypopressive exercises, pelvic floor, pelvic floor rehabilitation, transversus abdominis.

Cite This Article: *Atkın İ, Tamgüç B, Kıvanç Y, Pehlivanoğlu BE. The Co-contraction Relationship Between Pelvic Floor Contraction and Transversus Abdominis: A Traditional Review. BAU Health Innov 2024;2(3):125–133.*

The pelvic floor (PF) forms the lower boundary of the abdominopelvic cavity. The deep pelvic floor muscles (PFM) consist of the *levator ani* muscle group, including the *puborectalis, pubococcygeus*, and *iliococcygeus* muscles. The superficial PFM include the *bulbospongiosus, ischiocavernosus*, *perineal* muscles, and the *external anal sphincter*.[1] Coordinated movement of the PFM requires their activation before an increase in intra-abdominal pressure to support organs and ensure urinary and fecal continence. The PF, in collaboration with other muscles surrounding the abdominal cavity, plays a critical role in generating and regulating intra-abdominal pressure and contributes to the stability of the lumbar spine.[2] However, when the PFM lose their automatic coordinated function, their timing, endurance, and strength during activation may become insufficient.[3] Dysfunction in the coordination of the PF and surrounding structures can significantly impair an individual's quality of life.

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Submitted: January 07, 2025 **Revised:** January 23, 2025 **Accepted:** January 31, 2025 **Available Online:** February 13, 2025

BAU Health and Innovation - Available online at www.bauhealth.org

PF function is synergistically linked to the activation of abdominal muscles. When the PFM are activated, concurrent contraction of the abdominal muscles occurs.[4] This co-activation requires the proper engagement of the *transversus abdominis* (TrA) and *internal oblique* muscles, as full PFM contraction is not possible without their involvement. Studies conducted on women have demonstrated that PF contractions of equal intensity can be achieved in standing, sitting, and lying positions; however, abdominal and PF muscle co-contraction patterns vary depending on the position. Electromyographic analysis of the interaction between abdominal muscles and the PF has revealed that the TrA and internal oblique are engaged during all PFM contractions.[5]

When the support and control mechanisms of the PFM are compromised, pelvic floor dysfunctions (PFD) may arise. These dysfunctions include urinary incontinence, organ prolapse, and anorectal system disorders. Factors such as variability in muscle fiber diameter, morphological changes in muscle structure, vaginal deliveries, and advancing age contribute to the onset of PFD.[6]

In individuals performing PFM contractions, it is hypothesized that a reciprocal co-contraction pattern may exist in interaction with the abdominal muscles. Through a review of the literature, we aim to evaluate the potential for synergistic activation between the TrA muscle and the PFM in these individuals. Furthermore, this study is anticipated to raise awareness among physiotherapists implementing PF rehabilitation programs regarding the necessity and importance of incorporating the TrA muscle into their interventions. Based on the available evidence, the potential benefits of abdominal muscle exercises as part of conservative management approaches for PFD will be assessed.

Materials and Methods

This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The PubMed, Google Scholar, Wiley, and Web of Science databases were searched for studies published between 2019 and 2024. A manual search was also conducted through the reference lists of the included articles. Randomized controlled trials and clinical studies were included in the analysis.

The inclusion criteria for the studies were as follows: research on the pelvic floor (PF), the relationship between the PF and *transversus abdominis* (TrA), the relationship between the diaphragm and TrA, current PF rehabilitation methods, and studies involving hypopressive exercises (HE). Studies that did not assess the activation between the PF or TrA were excluded.

A five-year review was conducted using keywords such as *pelvic floor, transversus abdominis, hypopressive exercises, pelvic floor rehabilitation*, and *co-activation*. Out of 810 studies, 11 met the inclusion criteria. The methodologies of the included studies are presented in Table 1.

This review was developed as part of the Musculoskeletal Rehabilitation course in the Doctoral Program in Physiotherapy and Rehabilitation at Bahçeşehir University Graduate Education Institute.

Research Results and Findings

Pelvic Floor

The PF is a multifunctional structure composed of muscle fibers, fascia, ligaments, and connective tissue, forming a hammock-like support at the base of the abdominopelvic cavity. PFM are categorized into superficial and deep muscle groups. The superficial muscles include the *bulbospongiosus, ischiocavernosus, perineal* muscles, and *external anal sphincter*. The deep PFM consist of the *levator ani* muscle group, which includes the *puborectalis*, *pubococcygeus*, and *iliococcygeus* muscles.

The PF provides anatomical support to pelvic and abdominal organs and plays a crucial role in the regulation of urinary, bowel, and sexual functions.[7] Additionally, the PF, along with the diaphragm superiorly and the TrA anteriorly, encircles the abdominal cavity, contributing to lumbar spine stability and the generation of intra-abdominal pressure.[2]

Pelvic Floor Dysfunction

The PF plays a vital role in supporting pelvic organs and maintaining continence. Dysfunction in the muscles, connective tissues, or nerves that constitute this structure is referred to as pelvic floor dysfunction (PFD). PFD is typically characterized by a broad spectrum of symptoms, including urinary and fecal incontinence, pelvic organ prolapse, chronic pelvic pain, and sexual dysfunction, all of which can significantly impair an individual's quality of life.[8,9]

Although PFD is more prevalent in women, it is also a significant health issue in men. In women, risk factors include pregnancy, childbirth trauma, hormonal changes following menopause, obesity, and advanced age.[10] In men, PF weakness following prostate surgery is a notable etiological factor.[11]

Modern medicine emphasizes the necessity of a multidisciplinary approach to understanding the

Table 1. All outcome measurement methods of included studies

Studies	Methods used in the study
Molnár at al. (2021)	• Demographic data analysis • Vaginal surface electromyographic (vsEMG) instrument (FemiScanTM MultiTrainerTM; Mega Electronics, Kuopio, Finland) • By ultrasound visualization (Z.ONARETM SP/musculoskeletal, 8 MHz, 35-mm curved linear array transducer)
Yoon at al. (2020)	• The M-mode ultrasound imaging system with 10Hzcurved linear transducer (Philips EnVisor HD; Roya Philips Electronics, Netherland) • Trunk Impairment Scale (TIS) • The Berg Balance Scale • The functional ambulation category (FAC)
Liang at al. (2022)	• MLD B8Plus Pelvic Floor Biofeedback Rehabilitation System (MLD Corporation, Nanjing, China) • Short-Form Health Survey-36 (SF-36) • İnter-recti distance (IRD) • By two-dimensional (2D) real-time ultrasonography
Molina-Torres at al. (2022)	• The Modified Oxford Scale • The Pelvic Floor Distress Inventory [PFDI-20] • The Pelvic Floor Impact Questionnaire [PFIQ-7] • The International Consultation on Incontinence Questionnaire [ICIQ]
Lyu at al. (2021)	• Ultrasound (Philips EPIQ5, B mode, 5 MHz C5-1 transducer; Philips Ultrasound, Inc., Bothell, WA, USA) • Two hand-held dynamometers (ANIMA uTas MT1; HHD Japan) • Biofeedback stabilizer (CHATTANOOGA GROUP INC, Hixson, TN, USA)
Hashem Boroojerdi at al. (2020)	• EMG (Bortec AMT-8 amplifier System) • Diagnostic Ultrasound (Ultrasonix-ES500, Canada)
Min Yu at al. (2022)	• The visual analog scale (VAS) • The of motion capture system (Vicon Inc., Oxford, England)
Park at al. (2024)	• Biofeedback core exercise (UBCE) • Fugl-Meyer assessment (FMA) • Time up and go (TUG) • 10-meter walking test (10MWT) • Functional independent measure (FIM) • Abdominal draw-in maneuver (ADIM)
Ge at al. (2022)	• B-mode ultrasonic imaging device (iuStar100, B-mode, 10 MHz linear detection, United Imaging Systems, Beijing, China) • The visual analog scale (VAS) • Bioelectrical impedance analysis (Inbody770, Beijing Gemeishengda Medical Equipment Co., Ltd., Korea).
Navarro Brazález at al. (2020)	• The Modified Oxford Scale • dynamometric speculum (Pelvimetre, Phenix, Montpellier, France) • surface electromyography (sEMG)
Moreno-Munoz at al. (2021)	• By a stabilometric platform (Sensor Medica, Rome, Italy • SonoScape S2 ultrasound system

pathophysiology of PFD and developing effective treatment strategies. Various treatment options are available, ranging from surgical interventions to pelvic floor physiotherapy, necessitating a tailored treatment plan for each individual. This article explores the fundamental physiology of PFD, its risk factors, clinical presentations, and contemporary management strategies in light of the current literature.

Tonic Activity Changes in Pelvic Floor Muscles

In the literature, pelvic floor (PF) hypertonicity and hypotonicity are described using various terms. The International Urogynecological Association (IUGA) and the International Continence Society (ICS) currently define these conditions as *neurogenic hypertonicity* and *non-neurogenic hypertonicity*, as well as *neurogenic hypotonicity* and *non-neurogenic hypotonicity*. These terms describe increases or decreases in muscle tone, including heightened or diminished contraction activity and changes in the viscoelastic components associated with various factors.[12]

These conditions of the PF may arise as primary outcomes of acute or chronic injuries to the PF and surrounding musculoskeletal structures or as adaptive responses to these regions. Factors associated with PF hypertonicity and hypotonicity include pelvic surgeries, traumatic vaginal delivery, traumatic injuries to the back or pelvic region, gait disorders, pelvic pain, perceived threats, and chronic stress.[13]

Researchers recommend abdominal muscle training models to stimulate tonic PF muscle (PFM) activity. This recommendation is supported by scientific evidence demonstrating the synergistic co-contraction of the PF and abdominal muscles during daily activities.[14] While the interaction between the PF and abdominal muscles is well documented in asymptomatic women, clinical practice guidelines for the conservative treatment of pelvic floor dysfunction (PFD) indicate that abdominal muscle training remains a neglected area. Integrating abdominal muscle training could improve clinical outcomes in patients with PFM dysfunction.[15] This is particularly important as PFM strength plays a crucial role in women's quality of life and can be enhanced through appropriate treatment programs.[16]

Respiratory Dysfunction

The relationship between the respiratory system and the PF represents a biomechanical and neurological interaction essential for postural control, pressure regulation, and movement coordination. Respiratory muscles, particularly the diaphragm, work in synchronization with the PFM to regulate abdominal and thoracic pressures. This coordination is critical for effective respiration and for maintaining PF functions, including urinary and fecal continence, organ support, and sexual function.[2]

During breathing, the diaphragm expands the thoracic cavity while increasing intra-abdominal pressure (IAP). In response, the PF reflexively activates to counterbalance this pressure increase, functioning as a supportive barrier. This natural breathing dynamic stabilizes pelvic organs through IAP changes.[17] However, disruptions in this mechanism can lead to both respiratory dysfunction and PFD. For instance, weak PFM or a dysfunctional diaphragm may contribute to conditions such as stress urinary incontinence, pelvic organ prolapse, and chronic pelvic pain.[18]

The connection between the PF and respiratory muscles becomes particularly evident during physical activity. During intense exercise or heavy lifting, increased IAP requires the PF to bear the load. Breath-holding and irregular breathing patterns can weaken the PFM and contribute to dysfunction.[19]

Therefore, proper training of breathing patterns is a vital component of physiotherapy and rehabilitation programs for PF health. The clinical significance of this relationship is increasingly recognized, and respiratory training is being integrated into PF therapies. Breathing techniques that promote optimal diaphragm function and PF support are considered effective tools in the treatment of both respiratory dysfunction and PFD.

Pelvic Floor and Transversus Abdominis Relationship: Co-activation Mechanisms

The co-activation of the transversus abdominis (TrA) muscle, diaphragm, and pelvic floor muscles (PFM) has been reported as essential and effective in stabilizing the lumbar spine. A study conducted in 2000 investigated whether simultaneous activation occurred between the PFM and the rectus abdominis (RA), external oblique (EO), and TrA muscles during maximal spinal contractions in three positions. Measurements were taken using electrodes placed on the pubococcygeus muscle during isometric abdominal exercises performed in supine and seated positions. The results demonstrated that certain abdominal movements activated the PFM.[14]

It has been argued that the synergy between the TrA and PFM is necessary to initiate tonic activity in the PF during targeted TrA activation. Studies, particularly those focusing on women with stress urinary incontinence, have suggested that TrA contraction increases tonic activity in the PFM, supporting resistance against gravity and intra-abdominal pressure. Additionally, urethral pressure has been shown to increase similarly during the contraction of the PFM and TrA individually. Furthermore, for women who struggle to contract their PFM, TrA contraction has been found to facilitate PF activation, making it a valuable tool in rehabilitation.[20]

In a study investigating the co-activation relationship between the TrA and PFM, ultrasound imaging was used to evaluate their synergy. When participants were asked to contract their PFM, the TrA was observed to displace significantly in the cranio-ventral direction. However, when both muscles were contracted simultaneously, this displacement was more pronounced than when the TrA was activated alone. This displacement mechanism highlights the synergy between the TrA and PFM and provides a model for understanding dysfunction mechanisms.[21]

It has been suggested that activating only the TrA muscles could potentially cause injury to the PFM, particularly if the synergistic relationship between the TrA and PFM is not adequately maintained. Isolated TrA contractions may lead to levator hiatus enlargement, pushing the PFM downward and causing unnecessary strain, potentially resulting in muscle weakening. Research has shown that during TrA contraction, there is a notable increase in the size of the levator hiatus. This increase may place additional stress on the PF and, over time, negatively impact the integrity of muscle structures. Therefore, it is emphasized that TrA contractions should occur in coordination with the PFM to avoid adverse effects on the PF.[22]

Rehabilitation Approaches

Pelvic floor muscle training (PFMT) was first proposed by Arnold Kegel in 1948 as a method to strengthen pelvic muscles weakened postpartum.[23] Since then, the effects of PFMT on the PF have been extensively studied. Research indicates that PFMT is effective in improving or completely resolving symptoms of stress and mixed urinary incontinence. Additionally, there is significant evidence supporting its utility in the conservative management of pelvic organ prolapse.

Hypopressive Exercises

Hypopressive exercises (HE) were developed in 1984 by Marcel Caufriez to improve PF conditions, particularly for urogynecological rehabilitation in postpartum women, and to strengthen the abdominal muscles without causing damage to the PF. This method is designed to support PF health and enhance the functionality of the abdominal region.[24]

The abdominal hypopressive technique (AHT) primarily involves the activation of the TrA muscle and is utilized in the treatment of PFM disorders. This technique, developed by Caufriez, has become increasingly popular, especially in European countries such as Belgium and France. Caufriez emphasizes that this method reduces intra-abdominal pressure by relaxing the diaphragm while simultaneously activating the abdominal muscles and PFM. Studies indicate that although AHT significantly activates the TrA compared to isolated PFM contractions, the combination of PFM contractions with AHT further enhances TrA activation.[21]

Caufriez developed a sequence of thirty-three consecutive HE combined with a hypopressive maneuver. These exercises are performed in various body positions, such as standing, kneeling, on all fours, seated, or supine. During the exercises, individuals pull their abdomen inward and expand their ribcage while performing a technique called expiratory apnea, where the breath is held at the end of exhalation. The primary theoretical aim of these HE is to reduce intra-abdominal pressure while increasing the basal tone of the PF and deep abdominal muscles without requiring voluntary activation. This method is particularly recommended for strengthening the PFM and supporting abdominal stability.[25]

The maneuvers involved in HE provide evidence supporting their potential use as an intervention in the treatment of PFD. HE are known to promote neuromuscular activation of the PF and abdominal muscles, leading to improved PFM endurance. Research also suggests that HE increase the thickness of the levator ani muscle, further supporting their positive effects on PFD treatment.[26]

Breathing Exercises

The diaphragm is a primary respiratory muscle that connects to the pelvic floor (PF) through the transversalis fascia. This fascia is tightly linked to the deeply situated transversus abdominis (TrA) muscle in the anterior abdominal wall. It transitions from the diaphragmatic fascia, which covers the diaphragm's inferior surface, to the pelvic fascia that surrounds the pelvis. The portion of the pelvic fascia that envelops the levator ani and coccygeus muscles of the PF is referred to as the "endopelvic fascia" or "fascia superior diaphragmatis pelvis." Studies have demonstrated that the diaphragm, deep abdominal muscles, and PF function synergistically during respiration. Consequently, it has been suggested that activating the pelvic floor muscles (PFM) during diaphragmatic breathing enhances respiratory efficiency and should be incorporated into PF rehabilitation programs.[27]

During respiration and circulation, the diaphragm and PFM move in harmony, transferring intra-abdominal pressure to the diaphragm via the PF and abdominal muscles during exhalation. The PFM are activated and move upward as the diaphragm ascends and the TrA contracts during exhalation. Conversely, as the diaphragm descends during inhalation, the PFM relax and move downward. Diaphragmatic breathing exercises are highlighted for increasing the participation of abdominal muscles in thoracoabdominal movements. The PFM work synergistically with the diaphragm and abdominal muscles to regulate intra-abdominal pressure. Therefore, PFM training programs are recommended to include task-specific exercises that incorporate activities aimed at managing intra-abdominal pressure through the abdominal wall and diaphragmatic actions. Studies on PF rehabilitation have demonstrated that combining respiratory exercises with abdominal muscle exercises results in higher recovery rates.[28,29]

The coordination of internal and external trunk muscles is crucial for core stabilization. These structures contribute to spinal stabilization, increased intra-abdominal pressure, and load reduction. A disruption in the synchronization of these structures, or the exclusive activation of external trunk muscles, increases the risk of injury. Neglecting or weakening these structures can complicate muscle management. Kubota et al.,[30] in their 2018 study, evaluated PFM contractions during respiration by having patients sit on a soft, durable foam cylinder (20.5 cm in length, 4 cm in diameter). Patients performed PFM contractions while breathing in through the nose and out through the mouth. The study concluded that this foam support facilitated PFM contraction during breathing exercises. Additionally, respiratory exercises were reported to reduce lower back pain caused by muscle coordination issues.

Discussion

The co-activation of PFM and the TrA plays a crucial role in overall muscle health and pelvic stability. The synchronization between these muscles not only provides mechanical support but also emerges as an effective strategy in maintaining PF health and managing dysfunctions. Studies have demonstrated that the functional relationship between PFM and TrA facilitates the development of novel approaches in the treatment of pelvic floor dysfunction (PFD). Specifically, hypopressive exercises (HE), neuromuscular stabilization techniques, and physiotherapy protocols implemented in various body positions provide valuable insights for understanding and optimizing the interactions between these two muscle groups. Within the scope of this discussion, findings from the existing literature will be evaluated, focusing on the clinical relevance of PFM and TrA co-activation.

Lyu et al. (2021),[31] Park et al. (2024),[32] and Liang et al. (2022)[33] have provided valuable insights into the importance of the co-activation between PFM and the TrA from various perspectives. The study by Lyu and colleagues demonstrated that the co-activation of PFM and TrA can be reliably assessed in healthy individuals, revealing that the synergistic interaction of these muscles offers functional advantages. Specifically, the study identified a significant relationship between the simultaneous contraction of the TrA and PFM and the elevation of the bladder. Park and colleagues investigated the effects of PF and TrA muscle co-activation on postural control and functional mobility in the context of stroke rehabilitation, utilizing ultrasound biofeedback methods. Their findings highlighted that synchronized activation between PF and TrA muscles improves balance control and motor function by regulating intra-abdominal pressure. Liang et al. evaluated the effects of electromyography (EMG) biofeedback-assisted PFM exercises on managing rectus diastasis (RD). In this study, which combined EMG biofeedback with neuromuscular electrical stimulation, the synchronized activation of TrA muscles with PFM contraction played a significant role in reducing RD. Additionally, biofeedback-assisted exercises enhanced PFM control. The common thread among these studies is the critical role of PF and TrA muscle co-activation from different methodological and clinical perspectives. While Lyu and colleagues focused on this relationship and its synergy during physical activities in healthy individuals, Park, Liang, and their respective teams emphasized the clinical applications and benefits of this co-activation in rehabilitation contexts. These findings suggest that rehabilitation strategies targeting the coordinated activation of PF and TrA muscles may have broad applicability, benefiting both healthy individuals and those with clinical conditions.

The studies conducted by Ge et al.[34] and Yu et al.[35] have explored the relationship between the co-activation of PFM and the TrA. Ge et al. measured the thickness of the TrA muscle using ultrasound and recorded changes observed during the simultaneous contraction of PF and TrA muscles. Muscle thickness was measured during the inspiration, expiration, and contraction phases. A significant increase in TrA muscle thickness was observed during the simultaneous contraction of PF and TrA muscles. This finding has been proposed as a useful parameter for assessing chronic low back pain. Yu et al., on the other hand, used three-dimensional motion analysis to investigate the effects of TrA and PFM co-activation on pelvic stability. Pelvic movements during walking were analyzed, and the impact of co-activation on pelvic stability was evaluated. Contraction of the TrA and PFM was found to reduce pelvic mobility and enhance stability. However, these effects were more pronounced in the coronal plane, with no significant changes observed in the sagittal and transverse planes. Combining motion analysis with muscle thickness measurements could provide more comprehensive insights into the integrated effects of these two methodologies. Both studies support the synergy between the PF and TrA muscles. From a clinical rehabilitation perspective, utilizing the static and dynamic synergy of PF and TrA muscles is considered beneficial.

Other studies, such as those by Yoon et al.[36] and Molina-Torres et al.,[16] examined the activation of PF and TrA muscles from different perspectives. Yoon aimed to compare dynamic neuromuscular stabilization (DNS) and neurodevelopmental treatment (NDT) methods by measuring TrA and diaphragm movements. Using ultrasound, diaphragm motion and the thickness of the TrA and internal oblique muscles were assessed. The DNS group demonstrated greater increases in diaphragm motion and TrA thickness compared to the NDT group. Co-activation of the TrA and diaphragm led to more effective improvements in postural control. DNS enhanced postural stability, providing better balance and gait capacity during movement. Molina-Torres investigated the effects of HE on PFM activation and urinary incontinence. HE resulted in significant improvements in PFM contractility and urinary incontinence symptoms. PFM activation during HE occurred in synchronization with the diaphragm and deep abdominal muscles. Participants also reported substantial improvements in their quality of life. These findings suggest that integrating PFM and TrA activation into clinical management could offer broader benefits for patients.

Moreno-Muñoz et al.[37] and Navarro Brazález et al.[25] investigated the activation of PF and TrA muscles using different methodologies. Moreno-Muñoz explored the effects of an abdominal AHT program on postural control and deep core muscle activation. Postural control was assessed using a stabilometric platform, while TrA activation was measured in real time via ultrasound. AHT significantly improved postural control and TrA activation. Stabilometric measurements revealed notable improvements in balance parameters, and a statistically significant increase in TrA contraction was observed. Navarro Brazález examined neuromuscular activation of PF and abdominal muscles during HE. Muscle activation was measured using EMG, and vaginal muscle strength was assessed with vaginal dynamometry. Exercises were performed in both supine and standing positions to compare the effects of hypopressive postures and maneuvers on muscle activation. During hypopressive maneuvers, both PF and abdominal muscles were actively engaged. The combination of posture and maneuver yielded more effective muscle activation. Both studies demonstrated the positive effects of AHT on muscle synergy. However, Moreno-Muñoz emphasized the effectiveness of longer intervention programs, while Navarro Brazález highlighted that combining hypopressive maneuvers with specific postures resulted in more effective muscle activation. Integrating these approaches may further enhance long-term clinical outcomes.

Hashem Boroojerdi et al.[38] and Molnar et al.[39] explored the co-activation relationship between PF and TrA muscles using different methodologies. Hashem Boroojerdi investigated the co-activation of TrA and PFM through various exercise protocols and postures. The study observed that proper breathing techniques and exercise regimens could enhance the co-activation between these muscles. The implemented protocols improved the endurance and functional capacity of the PFM. Molnar applied a PFM training program in different body positions. Exercises performed in the supine position significantly increased PFM endurance and dynamic rapid contraction capacity. In contrast, exercises conducted in the sitting position enhanced PFM relaxation and improved resting muscle tone. TrA thickness increased in both postures, although the effects varied depending on the position. These studies emphasize the importance of coordinated activation of PF and TrA muscles, suggesting that their synergy could yield more effective outcomes in clinical applications. Leveraging this synergy through diverse exercise protocols and posture-specific approaches is expected to further amplify therapeutic effects.

Conclusion

This review consolidates studies examining the co-activation of the pelvic floor (PF) and transversus abdominis (TrA) muscles, highlighting their effects on muscle health, pelvic stability, and posture. The findings underscore the crucial role of PF and TrA synergy in managing pelvic floor dysfunction (PFD) and enhancing postural stability during rehabilitation. These results not only confirm the presence of PF and TrA co-activation but also suggest that rehabilitation exercises can be tailored to individual needs for optimal outcomes. Future research is needed to assess long-term effects and validate these methods in larger populations.

Disclosures

Authorship Contributions: Concept – İ.A., B.E.P.; Design – İ.A., B.E.P.; Supervision – İ.A., B.E.P.; Data collection and/or processing – İ.A.; Data analysis and/or interpretation – İ.A.; Literature search – İ.A.; Writing – İ.A.; Critical review – İ.A., B.T., Y.K.

Conflict of Interest: All authors declared no conflict of interest.

Use of AI for Writing Assistance: Artificial intelligence was used in the text editing and translation support of this review.

Financial Disclosure: The authors declared that this study received no financial support.

Peer-review: Externally peer-reviewed.

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