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STRESS URINARY INCONTINENCE AMONG FEMALE STRENGTH ATHLETES: A REVIEW OF PATHOMECHANISM, RISK FACTORS, DIAGNOSTIC ASSESSMENT, AND REHABILITATION

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ABSTRACT

Background: Stress urinary incontinence is a common pelvic floor disorder among women and is increasingly recognized in female strength athletes. Urinary leakage may occur during heavy resistance exercise and high-impact activities that substantially increase intra-abdominal pressure. Despite its prevalence, stress urinary incontinence is frequently normalized and underreported by athletes.

Objective: This review aimed to synthesize current evidence regarding the pathomechanisms, risk factors, diagnostic assessment, and rehabilitation of stress urinary incontinence in female strength athletes.

Methods: A literature search was conducted in PubMed, Scopus, and Google Scholar for peer-reviewed English-language publications from database inception to September 2026. Studies addressing stress urinary incontinence, pelvic floor function, female athletes, resistance training, and rehabilitation were included.

Key findings: The reviewed evidence indicates that stress urinary incontinence in female strength athletes is associated with the interaction of increased intra-abdominal pressure, pelvic floor muscle function, neuromuscular coordination, exercise characteristics, and individual risk factors. High prevalence has been reported among strength and CrossFit athletes, including young and nulliparous women. Assessment should include clinical history, symptom evaluation, a micturition diary, and pelvic floor muscle assessment. Pelvic floor muscle training remains the primary conservative treatment, while biofeedback, electromyography, and ultrasound may assist with correct muscle activation. However, evidence regarding their additional benefits remains limited.

Conclusions: Stress urinary incontinence should not be considered an inevitable consequence of strength training. Early recognition, education, and individualized pelvic floor rehabilitation are important, while further research is needed to establish sport-specific diagnostic and treatment protocols.

KEYWORDS

Stress Urinary Incontinence, Female Athletes, Strength Training, Pelvic Floor Muscles, Rehabilitation, Resistance Training

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1. Introduction

Stress Urinary Incontinence (SUI) represents the most common form of lower urinary tract dysfunction among women. According to the official definition by the International Continence Society (ICS), SUI is characterized as the complaint of involuntary loss of urine on effort or physical exertion, or on sneezing or coughing, which transiently elevates intra-abdominal pressure (IAP) [1].

The underlying pathomechanism stems from an imbalance between a sudden surge in IAP and the closure capacity of the urethra, which relies on the functional integrity of the pelvic floor muscles (PFM), connective tissue supports, and urethral vascularization [2]. In sports science, this presentation is described as athletic incontinence. This pattern of involuntary urine leakage, occurring predominantly or exclusively during high-load training sessions in athletes who otherwise report complete continence during daily activities, has been documented empirically in this population [3].

While physical activity is universally recommended as one of the elements of health promotion and low-intensity activity can be protective against SUI, high-intensity exercise and heavy resistance training have been identified as potential risk factors for SUI [4]. Epidemiological studies demonstrate that the prevalence of SUI among female strength athletes is alarmingly high, ranging from 28% to 80% [5].

Despite its high prevalence, stress urinary incontinence (SUI) among female strength athletes remains largely unaddressed. Mahoney et al. found that among 425 female strength athletes, 59.1% experienced incontinence during regular strength training and 50.2% during competition, with 61.4% of those affected reporting that the condition had not been present before they began their sport [4]. Similarly, in a systematic review and meta-analysis of CrossFit practitioners, Dominguez-Antuña et al. reported a pooled urinary incontinence (UI) prevalence of 44.5% across 3,682 women, with SUI accounting for 81.2% of cases and

significantly higher odds of UI in CrossFit athletes compared to non-athletic controls [6]. Yet despite these figures, help-seeking behavior remains strikingly low: only 9.4% of affected athletes in the Mahoney et al. sample had ever sought treatment. This gap appears closely tied to normalization of the condition, as 67.9% of all athletes surveyed believed urinary incontinence to be an unremarkable, expected part of their sport [4]. Taken together, these findings suggest that SUI in strength athletes is not only common but is also systematically underreported and undertreated, largely because it has come to be perceived as a normal cost of training rather than a treatable dysfunction. Furthermore, this condition not only degrades quality of life, causes psychological distress, and induces shame, but it also forces many women to adopt sub-optimal movement compensations, modify their training, or stop participating in strength sports altogether [7,8].

This shows the need for greater awareness, screening and accessible rehabilitation pathways within the population of female athletes. Thus, the primary aim of this review paper is to synthesize and critically analyze current scientific evidence regarding the pathomechanisms, risk factors, diagnostic assessment, and effective physical therapy interventions for women experiencing SUI in connection with resistance training.

2. Methodology

A comprehensive literature search was conducted across the PubMed, Scopus, and Google Scholar databases. The search was limited to peer-reviewed literature published in English from database inception up to September 2026, with a particular focus on studies published within the last decade to reflect modern strength training modalities.

The search strategy utilized relevant search terms covering condition and pathology ("stress urinary incontinence", "pelvic floor dysfunction", "athletic incontinence"); target population ("female athletes", "powerlifting", "weightlifting", "strength sports", "resistance training"); and management ("diagnostic assessment", "pelvic floor muscle training", "rehabilitation", "breathing mechanics", "Valsalva maneuver").

Publications were eligible for inclusion if they provided pertinent empirical data, mechanical analyses, or clinical insights into pelvic floor function during high-load resistance training. Inclusion criteria involved: original research articles, observational studies, clinical trials, and authoritative review papers written in English; cohorts involving females participating in strength, power, or high-load resistance training; and studies evaluating pelvic floor biomechanics, risk factors, intra-abdominal pressure generation, diagnostic protocols, or physical therapy interventions for SUI. Non-peer-reviewed sources, editorials, and conference abstracts without full text were excluded.

Identified records were screened by title and abstract, followed by a full-text analysis. Selected sources were synthesized narratively and categorized into key thematic domains: pathomechanism, risk factors, diagnostic assessment, and rehabilitation.

3. Results

3.1 Biomechanics and Functional Anatomy of the Pelvic Floor in Resistance Training

The pelvic floor muscles (PFM) consisting of the levator ani muscle group (puborectalis, pubococcygeus, and iliococcygeus) and the coccygeus, form the inferior anatomical closure of the abdominopelvic cavity [9]. Functionally, the PFM do not act in isolation, but rather form the base of the dynamic "deep core" functional unit. This anatomical capsule is bordered superiorly by the thoracic diaphragm, anteriorly and laterally by the transversus abdominis, and posteriorly by the lumbar multifidus [10]. Under physiological conditions, the thoracic diaphragm and the PFM exhibit a synergistic postural-respiratory relationship: during inspiration, the descent of the diaphragm increases intra-abdominal pressure (IAP), evoking an eccentric, lengthening contraction of the PFM to accommodate the downward displacement of the pelvic viscera. Conversely, during expiration, the PFM concentrically contract and ascend in coordination with the recoil of the diaphragm [11]. Maintaining this coordinated motor control and myofascial compliance is critical for both spinal stabilization and urethral continence during high-load resistance tasks [9,10].

In heavy resistance training, such as performing maximal or near-maximal squats, deadlifts, and overhead presses, athletes intentionally generate substantial elevations in intra-abdominal pressure (IAP) to augment spinal stiffness and reduce compressive loads on the lumbar spine [12,13]. This pressurization is primarily achieved through the execution of the Valsalva maneuver, defined as a forced expiratory effort against a closed glottis following a deep inhalation. This action leads to a simultaneous isometric contraction of the abdominal wall musculature and the thoracic diaphragm, effectively turning the abdominal cavity into

a rigid "hydraulic cylinder" [13]. While this elevated IAP provides vital structural support for heavy lifting, it exerts immense downward vector forces on the pelvic cavity floor [9]. In powerlifters and strength athletes, IAP values during compound lifts can exceed 150–200 mmHg, placing unprecedented structural demand on the supporting pelvic organ connective tissues and urethral closure mechanisms [12,13].

Under normal physiological conditions, a sudden surge in IAP triggers a reflexive, feed-forward co-activation of the PFM prior to or simultaneously with the movement onset [14]. This pre-contraction elevates the bladder neck and compresses the mid-urethra against the supportive sub-urethral vaginal wall ("hammock hypothesis"), preventing involuntary urine loss [2]. In women exposed to chronic high loading, the PFM can undergo structural remodeling, including increased thickness and cross-sectional area, though the functional significance of this adaptation is debated, since increased bladder neck descent has also been reported in the same populations [15]. However, when the magnitude or rate of IAP generation exceeds the dynamic closure capacity of the PFM, or when repetitive high-load exposures induce local muscular fatigue, a breakdown in structural support occurs [9]. This mismatch leads to depression of the pelvic organ structures, mechanical incompetence of the urethral sphincter, and the consequent involuntary loss of urine characteristic of athletic stress urinary incontinence [2,9].

3.2 Risk Factors, Movement Compensations, and Intra-Workout Triggers

The manifestation of athletic stress urinary incontinence varies significantly according to the biomechanical loading characteristics of the athletic movement. Maximal compound lifts, such as heavy back squats and deadlifts, generate sustained, continuous surges in intra-abdominal pressure that place severe downward displacement forces on the pelvic floor muscles and pelvic connective supports [9]. Conversely, high-impact dynamic tasks—such as plyometrics, double-unders, and box jumps, which are ubiquitous in CrossFit programming introduce rapid, repetitive peak ground reaction forces. These dynamic impact events demand instantaneous, reflex-driven PFM contractions to maintain urethral closure [16]. While heavy resistance lifting primarily tests the absolute force capacity and structural stiffness of the pelvic floor, repetitive plyometric exercises induce severe dynamic muscle fatigue, compromising the speed and coordination of the stretch-shortening reflex required to maintain urinary continence during multi-modal conditioning circuits [9,17].

A primary contributor to intra-workout incontinence in strength athletes is improper breath-holding mechanics and dynamic movement compensation. While an expertly executed Valsalva maneuver optimizes lumbopelvic stability by increasing IAP, technical errors, such as breath-holding at suboptimal lung volumes or performing forced downward bearing-down rather than maintaining an upward co-contraction of the deep core, direct the pressure vector inferoposteriorly onto the pelvic bowl [18]. This misdirected force depresses the bladder neck and overcomes urethral closure resistance. Furthermore, as athletes approach neuromuscular exhaustion during high-repetition or near-maximal sets, the feed-forward pre-contraction of the PFM degrades, resulting in asynchronous recruitment where IAP spikes precede pelvic floor closure, culminating in transient mechanical incontinence [17].

Individual risk for athletic SUI is governed by interaction between sport-specific mechanical demands and inherent physiological vulnerabilities. Discipline-specific prevalence rates reflect these differences: Olympic weightlifters present a higher risk of SUI than CrossFit athletes, likely driven by their exposure to extreme absolute IAP loads during maximal lifts, while CrossFit athletes nonetheless report a high overall prevalence owing to their combined exposure to heavy load lifting and high-impact ballistic activities [6,19]. While prior vaginal delivery remains the strongest established risk factor for PFM structural injury and denervation, high SUI prevalence in nulliparous, young female athletes suggests that athletic loading alone can exceed physiological continence thresholds [8,20]. Furthermore, elevated body mass index (BMI) chronically increases resting baseline IAP, compounding the acute stress of external loads [20]. Finally, intrinsic connective tissue variations, such as altered ratios of type I to type III collagen and systemic joint hypermobility, reduce the passive tensile stiffness of the endopelvic fascia, heightening structural vulnerability under heavy training regimens [20,21].

3.3 Diagnostics and Assessment of Pelvic Floor Muscle Function in Stress Urinary Incontinence

A crucial component of stress incontinence is pelvic floor muscle dysfunction. Monitoring pelvic floor muscle function can support the prevention, early detection, and treatment of the condition [22,23].

3.3.1 History taking

Every examination should begin with a detailed history of the patient's symptoms and their impact on quality of life and sexual function. It is also essential to establish the patient's expectations and treatment goals. This information helps the physician determine the type of urinary incontinence and assess its severity. The use of absorption pads can also provide an indication of symptom intensity. Questionnaires such as the ICIQ-UI SF, PRAFAB, and 3IQ may be used to support the clinical assessment and diagnosis [22].

3.3.2 Urinary tract infections

When assessing SUI, it is important to rule out urinary tract infections (UTIs), as they can cause symptoms similar to those of urinary incontinence. Urine analysis and culture may be performed to identify a possible infection [22].

3.3.3 Micturition diary

The patient records all urinary output, leakage or urgency events, liquid consumption, and the number of pads used. The diary can be helpful in both the assessment of the type of incontinence and the treatment plan. Patients with stress incontinence typically have a normal voiding frequency and bladder volume with neither urgency nor nocturia. However, they may experience small amounts of urine leakage during physical exertion or exercise [23].

3.3.4 Clinical evaluation

The examination should include the assessment of external genitalia (signs of irritation), urethral and rectal regions, and vagina, paying attention to any abnormalities, adhesions, tenderness, and pain. In peri- and post-menopausal women, it is crucial to identify signs of vulvovaginal atrophy and the pH [22].

Pelvic floor muscle function assessment verifies the patient's voluntary control of the pelvic floor. In order to exercise them, the patient must be able to contract and relax them. Before digital insertion, it is crucial to determine if an internal examination can be tolerated. Vaginal and rectal palpation can then be performed to evaluate resting muscle tone and contractile function. There is no universally accepted range for defining normal, hypertonic, or hypotonic pelvic floor muscle tone; hence, it should be assessed in correlation with the patient's symptoms. A correct pelvic floor contraction is the encircling, tightening, and inward or cranial movement around the examiner's finger. Next, relaxation should be evaluated by the pelvic floor muscles returning to their resting state. Digital palpation is assessed using the 6-point Oxford scale. Stress urinary incontinence can be verified by the cough test, which is performed with a full bladder. Overall, these assessments help identify pelvic floor muscle dysfunction and urinary incontinence and provide a basis for appropriate treatment and rehabilitation [22,23].

3.4 Management Strategies and Therapeutic Options for Stress Urinary Incontinence

The main objective of SUI treatment is to eliminate incontinence. Initially, start with simple lifestyle changes, such as limiting fluid intake before exertion and voiding before workouts. Next, implement pelvic floor physiotherapy alongside pharmaceutical treatments if necessary [25].

Several studies have reported improvements in urinary leakage, pelvic floor muscle strength, vaginal resting pressure, and maximal voluntary contraction following PFM training. For example, research involving athletes has demonstrated reduced SUI symptoms after structured pelvic floor rehabilitation, while randomized trials in women with SUI have suggested that PFM training may be more effective than abdominal hypopressive techniques. Kegel exercises, which focus on contraction and relaxation of PFM, are often used in rehabilitation programs. However, many patients confessed that understanding what and where the muscles are is the most difficult part of starting the training process. Once patients are able to isolate their PFM, it is important they follow instructions, eg., “tighten the muscles around the examiner’s finger by pulling up and inward” or “imagine stopping bowel gas by tightening the muscles around the anus, without tensing the legs or buttocks”. If that is unhelpful, suprapubic ultrasound can be used as a non-invasive method to help women identify and learn correct PFM activation [25].

Biofeedback (BF) is another way in which PFM training could be improved. It shows patients the response to muscle activity and contraction intensity, which could raise awareness and motivation during a training session. Electromyography (EMG) can be incorporated into BF to record the electrical activity of the pelvic floor muscles and provide visual or auditory feedback, allowing women to monitor whether contractions are being performed correctly. Studies have shown progress in Kegel exercises when combining training with EMG; however, further research needs to be conducted to determine how much additional benefit BF provides compared with PFM exercises alone [24]. Additionally, PFM training is recommended; however, research, specifically involving young nulliparous athletes, is still developing, meaning that its effectiveness in this population should not be assumed to be identical to that observed in other groups of women with SUI [25].

Pharmacological and surgical treatments are not that widely utilized in young athletes as urinary leakage occurs primarily during high-impact exercise. Medications such as duloxetine and certain adrenergic agents may be used in selected patients, while surgical procedures such as mid-urethral slings are usually reserved for specific clinical circumstances. Some solutions such as pessaries and vaginal tampons may be used as urethral support during exertion. It is important to note that physical activity should still be recommended for patients with SUI as it provides substantial health benefits. Exercise aids in maintaining a healthy weight, which in turn reduces the risk of conditions associated with urinary incontinence. Overall, athletes should be encouraged to remain physically active while receiving appropriate education and training in PFM activation. Nevertheless, given the inconsistent findings and limited sample sizes in existing studies, further rigorous research is required to establish definitive PFM and biofeedback protocols for female athletes [26,27].

4. Discussion and Conclusions

Stress urinary incontinence is a common but frequently misunderstood and underreported problem among young female athletes. It is not necessarily an inevitable consequence of high-intensity sport, but rather a complex result of a mix of intra-abdominal pressure, pelvic floor muscle function, neuromuscular coordination, training style, and individual factors. It is important to note the high prevalence of SUI among female athletes, including young and nulliparous women, which emphasizes the need to recognize athletic incontinence as a relevant clinical problem rather than limiting its consideration to women with a history of pregnancy or childbirth. The exact mechanisms responsible for SUI in strength athletes cannot yet be considered fully established, as research remains heterogeneous. Assessment should begin with a detailed history, evaluation of symptoms and their impact on quality of life, a micturition diary, and appropriate clinical examination. Assessment of pelvic floor muscle contraction and relaxation, including digital palpation and standardized scales, may help identify dysfunction and guide rehabilitation. Pelvic floor muscle training currently is the most popular approach to SUI treatment. Available evidence suggests that structured PFM training can reduce urinary leakage and improve pelvic floor muscle function. However, research concerning young female athletes remains scarce, and the benefit of biofeedback or EMG-assisted training over conventional PFM training is still unknown. More studies are required to determine optimal training frequency, intensity, exercise selection, breathing strategies, and long-term outcomes. From a practical perspective, physiotherapists should consider SUI screening as part of the assessment of female strength athletes, particularly when leakage occurs during squats, deadlifts, jumping, running, or other high-load activities. Athletes should be educated not to normalize these symptoms but rather treat them. Rehabilitation should initially focus on teaching correct pelvic floor contraction and relaxation, followed by functional tasks and gradually incorporate the positions, loads, and movement patterns that provoke symptoms. Coaches may help by creating a safe environment in which athletes feel comfortable coming to them with that issue. Overall, an interdisciplinary approach involving athletes, coaches, physiotherapists, and physicians may yield the best possible results in SUI management in female athletes.

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