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Physical Activity and Lower Urinary Tract Function: Pathophysiological Mechanisms, Clinical Evidence, and Practical Implications – A Narrative Review

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ABSTRACT

Lower urinary tract function (LUTF) depends on complex interactions between the detrusor muscle, urethral sphincters, pelvic floor musculature, and central and peripheral neural control. Disruption of these mechanisms may lead to lower urinary tract symptoms (LUTS), including urinary incontinence, urgency, frequency, nocturia, and voiding dysfunction, which substantially impair quality of life and participation in physical activity. Physical activity is a modifiable lifestyle factor that may exert both beneficial and adverse effects on urinary tract function. Moderate, well-structured exercise enhances pelvic floor muscle strength, neuromuscular coordination, metabolic health, and autonomic regulation, whereas excessive or high-impact training may exceed pelvic floor adaptive capacity and increase susceptibility to LUTS. This narrative review synthesizes contemporary evidence (2020–2025) regarding epidemiology, pathophysiological mechanisms, sport-specific risk profiles, and clinical outcomes related to physical activity and LUTF, and discusses practical implications for screening, prevention, and clinical management in physically active populations.

Keywords: physical activity, lower urinary tract symptoms, pelvic floor, urinary incontinence, sports medicine, exercise physiology

1. Introduction

Lower urinary tract symptoms affect a substantial proportion of adults worldwide and represent a significant public health burden due to their negative impact on quality of life, psychological well-being, occupational functioning, and healthcare utilization [1]. Although LUTS are traditionally associated with aging and urological disease, increasing evidence indicates that they are also prevalent among younger, physically active individuals, including recreational exercisers and elite athletes [3,4].

Established risk factors for LUTS include age, sex, hormonal status, pregnancy, obesity, and comorbidities such as diabetes and neurological disorders. However, lifestyle-related determinants, particularly physical activity, have gained increasing attention as potentially modifiable contributors [2]. Regular physical activity improves cardiovascular and metabolic health and may positively influence pelvic floor muscle (PFM) performance, connective tissue properties, and autonomic nervous system regulation. Conversely, repetitive high-impact loading, sustained elevations in intra-abdominal pressure, and inadequate recovery may challenge pelvic floor integrity and continence mechanisms [3,4].

Given the heterogeneity of findings across urology, sports medicine, and physiotherapy literature, an integrated synthesis is required. The aim of this review is to provide a comprehensive overview of current evidence regarding the relationship between physical activity and LUTF, with particular emphasis on pathophysiological mechanisms, sport-specific risks, sex-related differences, and practical implications for clinical practice.

2. Materials and Methods

A narrative literature review was conducted using PubMed, Scopus, and Google Scholar. Search terms included *physical activity*, *exercise*, *lower urinary tract symptoms*, *urinary incontinence*, *pelvic floor*, *pelvic floor dysfunction*, *athletes*, and *sports*. Publications from January 2020 to May 2025 were prioritized, including systematic reviews, randomized controlled trials, observational studies, and clinical guidelines. Earlier landmark publications were included selectively to provide physiological and biomechanical context. Due to heterogeneity in study design and outcome measures, a qualitative synthesis approach was applied.

3. Pathophysiological Mechanisms Linking Physical Activity and LUTF

3.1 Pelvic Floor Muscle Structure and Function

The pelvic floor muscles provide dynamic support to pelvic organs and play a central role in maintaining urethral closure during increases in intra-abdominal pressure [6]. Adequate PFM function requires not only maximal strength but also endurance, coordination, and anticipatory activation. Moderate physical activity and targeted pelvic floor muscle training enhance these parameters and improve continence during functional tasks [7,8].

In contrast, repetitive exposure to high-impact forces may induce fatigue-related neuromuscular alterations, delayed activation, and altered recruitment patterns. Over time, these changes may compromise urethral support and increase susceptibility to stress urinary incontinence, particularly during jumping, sprinting, and change-of-direction movements [3,9].

3.2 Neural and Autonomic Regulation

Bladder storage and voiding depend on coordinated sympathetic, parasympathetic, and somatic neural pathways. Regular moderate exercise is associated with improved autonomic balance, characterized by increased parasympathetic tone and enhanced heart rate variability, which may stabilize detrusor activity and reduce urgency symptoms [10]. Excessive training loads, psychological stress, and insufficient recovery may disrupt autonomic regulation and promote sympathetic predominance, potentially contributing to detrusor overactivity and dysfunctional voiding [11].

3.3 Biomechanical Factors and Intra-Abdominal Pressure

High-impact physical activities generate repetitive spikes in intra-abdominal pressure. Continence during such activities depends on the ability of the pelvic floor to counteract these forces through timely and coordinated contraction [6,12]. Exercise-induced increases in intra-abdominal pressure have been directly linked to leakage episodes in susceptible individuals, highlighting the importance of neuromuscular timing rather than maximal force generation alone [12].

3.4 Metabolic and Inflammatory Pathways

Chronic low-grade inflammation, insulin resistance, and metabolic dysfunction have been implicated in LUTS pathogenesis [5]. Physical activity reduces systemic inflammatory markers, improves insulin sensitivity, and supports vascular health, which may indirectly benefit bladder function and symptom severity [13].

4. Sex- and Age-Specific Considerations

4.1 Female Populations

Women are disproportionately affected by exercise-related LUTS due to anatomical, hormonal, and connective tissue factors. Pregnancy, childbirth, and menopause are associated with structural and functional changes that may reduce pelvic floor resilience under mechanical load [14,15]. Female athletes participating in high-impact sports demonstrate particularly high prevalence of stress urinary incontinence, even in the absence of obstetric history [9].

4.2 Male Populations

Although LUTS are traditionally considered a predominantly male issue in older age groups, physically active younger men may also experience storage and voiding symptoms. Potential mechanisms include pelvic floor overactivity, perineal pressure (e.g. cycling), and sport-specific loading patterns [16]. Evidence in male athletes remains limited and represents an important gap in the literature.

4.3 Aging and Neuromuscular Decline

Age-related declines in neuromuscular control, muscle mass, and connective tissue elasticity may modify the relationship between physical activity and LUTF. While physical activity remains beneficial in older adults, exercise prescription should account for age-related vulnerability of the pelvic floor [17].

Sex- and age-specific mechanisms and clinical manifestations of lower urinary tract symptoms in physically active populations are summarized in **Table 2**.

Table 2. Sex- and age-related differences in mechanisms, risk factors, and clinical manifestations of LUTS associated with physical activity.

Population	Key mechanisms influencing LUTF	Typical LUTS presentation	Risk-modifying factors	Key references
Young physically active women	High-impact loading, neuromuscular fatigue	Stress UI during sport	Sport type, training volume	[2,3,9,15,19]
Pregnant/postpartum women	Hormonal and connective tissue changes	Stress/mixed UI	PFMT, timing of return to sport	[7,14,15]
Postmenopausal women	Reduced estrogen, neuromuscular decline	Stress/urgency UI	Hormonal status, intensity	[2,6,17]
Young/middle-aged men	Pelvic floor overactivity, perineal pressure	Voiding symptoms	Sport type, ergonomics	[10,16]

Older adults	Sarcopenia, autonomic dysregulation	Mixed LUTS	Functional capacity	[13,17,18]
Elite athletes	Chronic overload, insufficient recovery	Exercise-induced UI	Load management	[3,9,20,21]

5. Sport-Specific Risk Profiles

5.1 High-Impact Sports

Sports involving repetitive jumping and high ground-reaction forces are consistently associated with higher prevalence of stress urinary incontinence [3,9,19].

5.2 Strength and Resistance Training

Properly dosed resistance training appears neutral or protective when combined with correct breathing and pelvic floor engagement [8,12].

5.3 Endurance and Low-Impact Sports

Endurance activities such as cycling are generally associated with lower LUTS prevalence, though prolonged perineal pressure may contribute to voiding symptoms [16].

6. Clinical Evidence

6.1 Protective Effects of Moderate Physical Activity

Population-based studies demonstrate that regular moderate-intensity physical activity is associated with lower prevalence of LUTS [13,18]. Interventions combining aerobic exercise with PFMT significantly improve continence-related outcomes [7,18].

A summary of sport-specific effects of physical activity on lower urinary tract function is presented in **Table 1**.

Table 1. Effects of different types and intensities of physical activity on lower urinary tract function and pelvic floor outcomes.

Type of activity	Population	Main findings	Clinical implications	References
Moderate aerobic activity	General adults	Lower LUTS prevalence	Preventive strategy	[2,13,18]
PFMT	Women	Improved continence	First-line therapy	[7,8,17]
High-impact sports	Female athletes	Higher SUI prevalence	Screening + PFMT	[3,9,15,19]
Resistance training	Recreational adults	Neutral/protective	Technique critical	[8,12]
Endurance sports	Male athletes	Possible voiding symptoms	Ergonomic optimization	[16]
Overtraining	Athletes	Increased LUTS risk	Recovery emphasis	[11,20]

6.2 Dose–Response Relationship

Available evidence suggests a U-shaped relationship between physical activity and LUTF, with moderate activity being protective and excessive training increasing LUTS risk [2,13].

7. Clinical Implications and Prevention Strategies

LUTS should not be regarded as an inevitable consequence of physical activity. Routine screening, pelvic floor–aware training, and multidisciplinary collaboration represent effective prevention strategies [20,21].

8. Limitations and Future Directions

Heterogeneity in study design and underrepresentation of male athletes limit conclusions. Future longitudinal and sport-specific studies are needed.

9. Conclusions

Moderate, well-structured physical activity supports lower urinary tract health, whereas excessive or high-impact training without pelvic floor adaptation may increase LUTS risk. Integrating pelvic floor strategies into exercise prescription offers a practical preventive approach.

Disclosures

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