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Review

Prevalence of pelvic floor dysfunction in male athletes and its dose-dependency in high-intensity exercise: A scoping review

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ABSTRACT

Background: This scoping review summarises literature on the prevalence and types of male pelvic floor dysfunction linked to increasing exercise intensity, with a secondary aim of exploring whether a dose-dependent relationship exists between the two.
Methods: A comprehensive search of CINAHL, PEDro, PubMed, Scopus, and Web of Science databases was conducted up to January 2025 using MeSH terms and keywords relating to exercise and PFD.
Results: The search yielded 6031 publications with 1199 duplicates removed prior to screening. After screening 4493 articles, 10 articles were eligible for inclusion. Substantial reporting differences of exercise-related variables were identified. Six studies reported prevalence rates of lower urinary tract symptoms (LUTS), including urinary incontinence, ranging from 3.8 % to 18.8 %. Only one study examined multiple pelvic floor issues, identifying anorectal incontinence in 61.8 % of participants. Studies investigating erectile dysfunction (ED) and chronic prostatitis/pelvic pain (CP/CPPS) reported hazard and odds ratios. When reporting as ratios for ED, CP/CPPS, studies identified that higher weekly MET-minutes of physical activity were slightly more protective than sedentary or lower physical activity levels. The cross-sectional studies reporting LUTS as a sample percentage identified a dose-dependent relationship between weekly MET-minutes and the prevalence of male LUTS, based on both minimum and maximum weighted averages ($R = 0.86$ vs. $R = 0.87$).
Conclusions: Athletic males may experience higher rates of LUTS than the general population. A dose-dependent relationship between MET-minutes per week and male LUTS indicates that men who exercise intensely at higher volumes may be at greater risk of symptomology, whereas risk of ED and CP/CPPS may be reduced.

What is already known?

- Increasing physical activity levels reduces the risk of erectile dysfunction and pelvic pain in males through systemic effects.
- High-impact exercise is associated with greater risk of pelvic floor dysfunction.

What are the new findings?

- A dose-dependent relationship exists between increased risk of male lower urinary tract symptoms and increasing MET-minutes of intensive exercise per week.

Practical implications

The introduction of routine screening protocols for pelvic floor symptoms in male athletes may facilitate early identification and management of pelvic floor dysfunction.

1. Introduction

A growing body of literature promotes a physically active lifestyle for the improvement of male pelvic floor function.[1] However, it is unclear if

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specific exercise modalities, intensities, and volumes influence risk of pelvic floor dysfunction (PFD) in males. Within female populations, it has not been possible to draw definitive conclusions about the role of chronic exercise and its influence on the development of PFD.[2] Recent conflicting literature suggests that strenuous exercise may place females at greater risk of PFD – something that is yet to be investigated in a male population.[3]

In males, moderate-to-vigorous physical activity improves pelvic floor health, whilst simultaneously reducing risk factors associated with pelvic floor dysfunction.[4–6] Literature has traditionally investigated the systemic protective benefits of physical activity, with many large organisations promoting physical activity and recommended that moderate intensity activity be performed most days of the week.[7–9] These systemic benefits include increased nitric oxide production and regulation of peripheral arterial pressures, along with improving glucose and lipid metabolism.[10] This improves the health of pelvic floor tissues and overall function, such as enhanced erection ability.[10] Physical activity also affects endogenous hormonal control and aids in the downregulation of the autonomic nervous system, improving lower urinary tract symptoms.[11] Although the systemic benefits provided by physical activity are apparent, there is little consideration regarding the deleterious effects exercise may directly have on the male pelvic floor musculature (PFM).

In males, healthy pelvic floor functioning is required for sexual function, anorectal and urinary continence and abdominal cavity support, particularly when intra-abdominal pressures (IAPs) increase during physical activity.[12] As IAP increases, the PFM fast twitch fibres are responsible for rapid augmentation of periurethral pressures and voluntary sphincteric control to maintain continence.[13,14] Like any skeletal musculature, such acute responses to exercise may induce PFM fatigue, as evidenced by lower resting and maximal rectal pressures when increasing metabolic equivalent of task (MET) activities in healthy men.[15] These acute pressure changes are possibly a normal fatigue response to exercise and not indicative of dysfunction.

Pelvic floor dysfunction refers to a broad collection of anatomical (structural) variations and symptoms associated with alteration of normal PFM functioning (see Table 1 for common male pelvic floor conditions).[16] Prevalence estimates vary, but recent data suggests that within the general adult male population, more than 1 in 2 men reported sexual difficulties in the 2017–18 period, and 1 in 6 reported pelvic pain.[17,18] Dependent on the specific pelvic floor structures involved, approximately 1 in 7 males experiences multiple pelvic floor dysfunctions.[19] Whilst mechanisms contributing to PFD are multifactorial, it was hypothesised that increased intra-abdominal pressure (IAP) changes and larger ground reaction forces (GRFs) may predispose an individual to PFD.[3] Increased IAP can occur from both high- and low-impact exercise; however, high-impact exercise and subsequently greater GRF increase the muscular demands on the pelvic floor. A growing body of evidence in females supports this, with higher-impact exercises resulting in greater urinary incontinence levels.[20] High- and low-impact exercise, and its influence on IAP and GRF changes in males have yet to be thoroughly investigated. Male PFD prevalence has recently been investigated in different exercise modalities within athletes.[21] The presence of PFD was attributed to the mode of exercise, with high-impact exercise increasing PFD risk.[21] High-impact sports have been linked with male infertility and PFD, possibly due to repetitive and acute stress to the PFM.[22,23] However, due to a number of variables including study design, methodology and low participant numbers, causation is unable to be determined.

Pelvic floor muscle training (PFMT) has been considered as the first-line management option for treating PFD.[25] Exercises are prescribed using a controlled and progressive approach to strengthen weak pelvic floor muscles and enhance motor control, including coordinated contractions and, where appropriate, relaxation training of the surrounding musculature.[16] The PFMT exercises are specifically prescribed to acutely induce PFM fatigue via voluntary contractions and strengthen them as a chronic adaptation.[26] Contrastingly, general exercise, whilst indirectly fatiguing the PFM, has not been shown to strengthen the PFM.[2,27] Athletes and women engaging in higher levels of exercise and activity levels are at greater risk of UI than age-matched controls.[2,3] Interestingly, there are no comparable studies within a male population.

Very limited research has investigated the direct and immediate effect that regular physical activity and exercise has on the male PFM and risk of PFD. Indeed, elevations in overall exercise or physical activity levels could, in theory generate excessive stress on the PFM.[3] If this persists for weeks or months, it is plausible that it may lead to unfavourable effects on PF function.[2] Mode of exercise appears to influence risk of male PFD, but further consideration into other exercise variables is required. How much does intensity or overall exercise volume influence the risk of PFM dysfunction? The aim of this review is to identify the prevalence and type of pelvic floor dysfunction in males participating in regular high-intensity exercise, and to examine the potential dose-dependent relationship between exercise intensity and prevalence.

2. Methods

The review was registered on the Open Science Framework and followed the preferred reporting items for systematic reviews and meta-analyses extension for scoping review (PRISMA-ScR) checklist for reporting.[28,29] The methodology was guided by the Joanna Briggs Institute Reviewers Manual 2020 Methodology for Scoping Reviews

Table 1
Male pelvic floor dysfunctions.[24]

Term	Definition	Common signs and symptoms
AI	Complaint of involuntary loss of flatus or faeces.	Soiling or staining of underwear; loss or reduced awareness of need to defecate
CP/CPPS	Persistent or recurrent prostate and/or pelvic pain, associated with symptoms suggestive of urinary tract and/or sexual dysfunction.	Persistent, intermittent or recurrent pain. Dyspareunia and/or ED. Voiding and post-micturition symptoms (e.g., hesitancy, intermittency, feeling of incomplete emptying, dysuria).
ED	Consistent or recurrent inability to attain and/or maintain a penile erection sufficient for sexual satisfaction and/or sexual intercourse. A form of sexual dysfunction	
LUTS	A symptom relating to the lower urinary tract; it may originate from the bladder, prostate, urethra, and/or adjacent PF or pelvic organs, or at times be referred from similarly innervated anatomy, for example, lower ureter. An umbrella term.	General storage symptoms (increased frequency, nocturia, polyuria); Sensory symptoms (absent/reduced/increased bladder filling sensation; urgency); Voiding symptoms ([urgency/stress/mixed] incontinence, enuresis, climacturia, hesitancy, straining, slow stream, intermittency, terminal dribbling, dysuria, retention); Post-voiding symptoms (feeling of incomplete emptying, need to immediately re-void, post-void incontinence, post-micturition urgency).
Prostatitis	An inflammatory disease of the prostate generally affecting younger men and causing pain and discomfort mostly in the perineal and scrotal region. It covers a wide range of clinical conditions including acute bacterial prostatitis, chronic bacterial prostatitis, CPPS (inflammatory and noninflammatory), and asymptomatic inflammatory prostatitis.	LUTS and/or sexual dysfunction
UI	Complaint of involuntary loss of urine.	A LUTS associated with involuntary loss of urine during the bladder storage phase

AI = anorectal incontinence; CP = chronic prostatitis; CPPS = chronic pelvic pain syndrome; ED = erectile dysfunction; LUTS = lower urinary tract symptoms; UI = urinary incontinence.

and scoping review framework by Levac.[30,31] The methods and eligibility criteria were established using the population, concept, context (PCC) mnemonic[31] (see Table 2).

For the purpose of this review, physical activity was defined as any bodily movement produced by skeletal muscle that results in energy expenditure.[32] Exercise was defined as a subset of physical activity that is planned, structured, and repetitive that has a final or an intermediate objective of the improvement or maintenance of physical fitness.[32] Keyword identification for search terms occurred through implementation of the International Continence Society (ICS) report on the terminology for sexual health in adult male lower urinary tract and pelvic floor symptoms and dysfunction.[33] In conjunction with these terms, an exploratory search of three electronic databases (CINAHL, PEDro, Scopus) for further keyword determination was conducted. This preliminary search identified a paucity of literature specific to the review aim. Therefore, it was hypothesised that insufficient evidence existed to justify a systematic review on this topic.[21]

Five electronic databases were searched by one reviewer up to January 2025. Databases included: CINAHL, PEDro, PubMed, Scopus, and Web of Science. A combination of MeSH terms and previously identified keywords encompassing prevalence, male pelvic floor dysfunction, exercise and physical activity was included (see Supplementary File for the Scopus search string). Additional search strategies utilised searching grey literature including Google Scholar with keywords and using the "suggested articles" feature synonymous to several of the included electronic databases. Reference lists of shortlisted and included literature were searched to assist in further study identification, by matching the selection criteria missed by the electronic database searches.

Three reviewers screened titles and abstracts, with full text reviewed by all four reviewers. Conflicts regarding final article inclusion were resolved by discussion. Extracted data included key demographic data, PFD type and outcome measure, exercise, or physical activity variables, including frequency, intensity, mode, and length of session.

Due to the broad inclusion criteria, the methodological quality of potential studies was assessed using the Crowe Critical Appraisal Tool (CCAT). The CCAT evaluates eight categories with 22 items and was chosen for its good construct validity and reliability (ICC = 0.74, absolute agreement) in a wide range of study designs.[34,35] Independent scoring of eligible literature was conducted by the authors. Where discrepancies existed, consensus was achieved by discussion.

The Compendium of Physical Activities was used to calculate the MET value of each activity.[36] Metabolic equivalent of task minutes per week was manually calculated for comparative purposes, due to substantial reporting differences on exercise-related variables between studies.[37,38] The MET-min per week calculation used was frequency of exercise (days) multiplied by exercise session length (minutes) multiplied by MET activity score. Where studies reported on numerical data in categorical fashion, as well as multiple exercise or physical activities, the minimum and maximum of each was used respectively. This calculation was completed to achieve an unbiased average of irregularly sampled data for comparative purposes. A minimum and maximum weighted average of MET-minutes was calculated where literature reported numeric data in a categorical fashion (i.e., a frequency of 1–3 days, 4–5 days and 6–7 days had minimum weighted averages with the combined lowest values in each category [1, 4, 6 days], with maximum weighted averages using the highest value of each category [3, 5, 7 days]). For example, where a study reported on volleyball (MET = 6), basketball (MET = 9.3) and soccer (MET = 10), both volleyball and soccer were used in the calculation for both the minimum and maximum MET-values. In the above example, the minimum weighted average was: 290 min × 6(MET) = 1740 MET-minutes per week, versus the maximum weighted average: 290 min × 10(MET) = 2900 MET-minutes per week.

This review considered peer reviewed studies, including randomised and pseudo-randomised control trials, comparative studies with and without controls, case series with pre-test/post-test outcomes, and longitudinal and observational (cross-sectional) studies. No limitation was placed on publication date. Literature was required to be published in the English language.

Table 2
Eligibility criteria.

	Inclusion criteria	Exclusion criteria
Participant(s)	Adult males aged 18–65 years.	Studies whose aims were specific to activities where participants with direct trauma or contact to the perineal region were excluded due to known risk factors in developing PFD (e.g., cycling and horseback riding).
Concept	Any PFD reported, inclusive of bowel symptoms, lower urinary tract symptoms, pelvic pain, or sexual dysfunction.	Studies including participants with a history of benign prostate hyperplasia or prostate cancer were excluded where studies did not conduct sub-group analyses of apparently healthy participants.
Context	Males participating in high intensity or voluminous exercise, or physical activity as defined by both: • Vigorousness, or intensity: Regular participation in vigorous physical activity or exercise ≥6 metabolic equivalent of task (MET); or ≥80%HR max. • Volume: ≥1000 MET-minutes per week.	Studies with unclear reporting of exercises or physical activities were excluded if they did not provide sufficient information through published or supplementary material; or, author contact was unable to be made.
Study design	Peer reviewed quantitative studies. No limitation on publication date. Published in English.	Reviews (± meta-analyses)

3. Results

Upon full text review, 10 articles were eligible for inclusion.[4,39–47] The PRISMA flow chart illustrates the selection process (Fig. 1).

3.1. Study characteristics

All studies reported on the prevalence of a type of PFD. The majority were cross-sectional in design (n = 8),[4,40–43,46,47,49] followed by cohort (n = 2).[39,45] Two of the included studies were secondary analyses of larger, ongoing studies.[4,39] Included literature was published across six countries: Brazil,[46,49] Korea,[39] Norway,[42] Spain,[40,41,47] Turkey,[43] and the USA.[4,45] Studies were published between 2015 and 2022.

3.2. Exercise reporting

Three studies included high impact exercises,[40,41,43] three studies reported on a combination of exercise types,[4,46,47] and one study focused solely on resistance training.[42] Two studies failed to disclose specific modes of exercise or physical activity but were able to be included because of their use of the International Physical Activity Questionnaire that used explicit exercise examples.[39,49] Volume of exercise and physical activity were self-reported and varied substantially across all included studies. Four studies measured volume and intensity via MET-minutes.[4,39,45,49] Six studies identified their participants as elite or high-level athletes where MET-minutes per week were manually calculated based on provided training history.[40–43,46,47] A full outline of results is presented in Table 3.

3.3. Quality appraisal

All included studies were observational by design, allowing for PFD prevalence to be clearly reported. The main strengths were the clarity

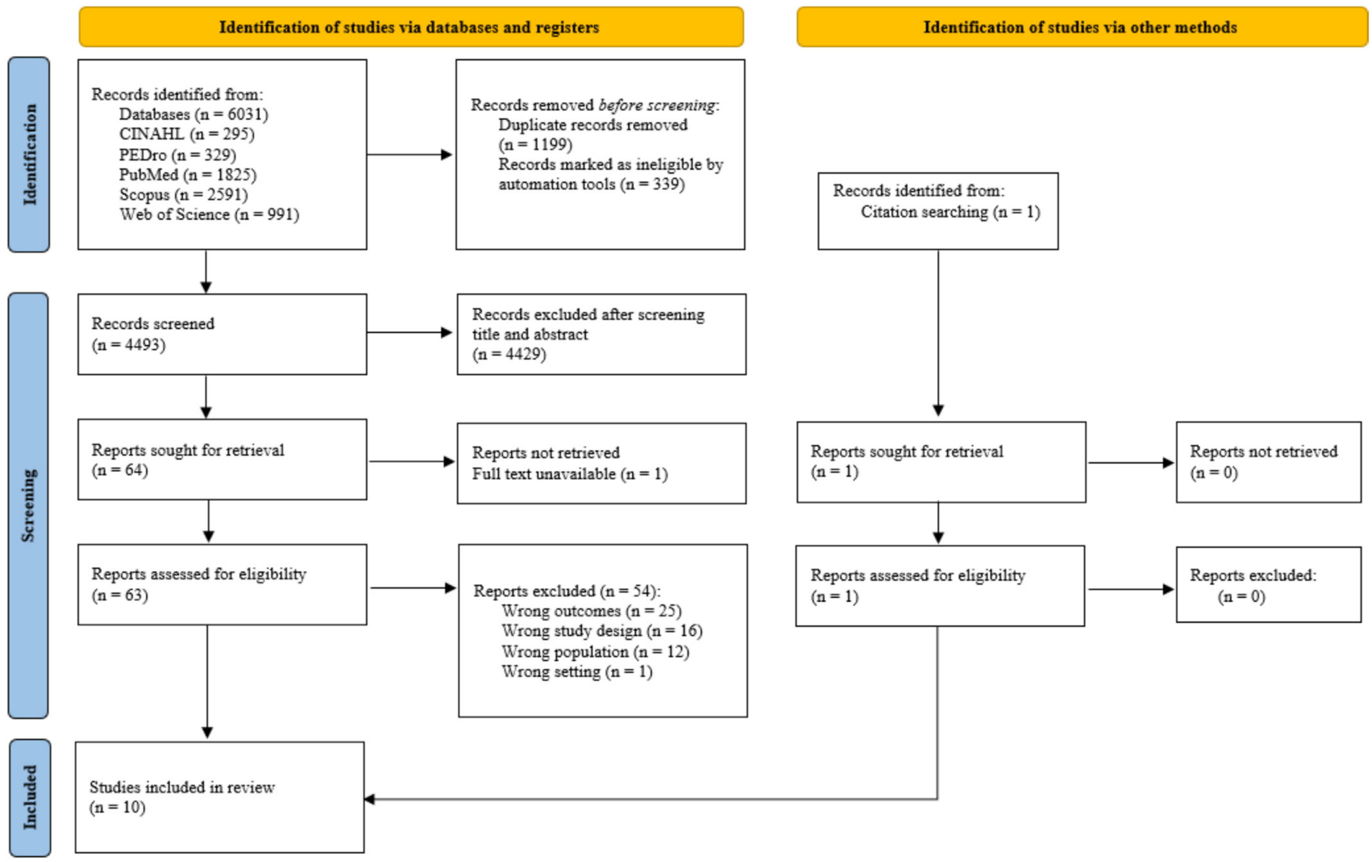

Fig. 1. PRISMA flow diagram outlining the literature selection process.[48]

and reporting of the inclusion criteria and demographic data. Most studies accounted for mediating variables including BMI, chronic disease unrelated to pelvic floor function, history of previous pelvic or lower back surgeries, and alcohol or smoking consumption. Study justification, design and sampling were clearly reported in most studies, with the main weaknesses being the inconsistent reporting of exercise mode, intensity and volume. Other weaknesses included variation in outcome measures and definitions of PFDs. Where further information was required, attempts were made to contact respective authors to seek clarification. A detailed critical appraisal is outlined below (see Table 4).

3.4. Prevalence of pelvic floor dysfunction

Three studies included internationally recognised definitions of pelvic floor dysfunctions[40,42,45]; seven studies used either the diagnostic component or cutoff scores of their respectively chosen outcome measures to determine the presence of PFD.[4,39,41,43,46,47,49] Six studies reported on the umbrella term of lower urinary tract symptoms (inclusive of UI) with reported rates between 3.8 % and 18.8 %.[39–41,43,46,47] Skaug et al. was the only study to report on multiple issues (LUTS and anorectal incontinence [AI]).[42] Of their sample, 61.8 % experienced accidental loss of gas, liquid, or solid stool during exercise.[42] Despite this high rate of AI, the overall mean bother score was low (1.2 ± 1.8, range: 0–10).[42]

Due to research design, studies investigating erectile dysfunction (ED) and chronic prostatitis/pelvic pain (CP/CPPS) failed to directly report prevalence, focusing instead on hazard and odds ratios. Two studies investigated the influence of physical activity on erectile dysfunction (ED),[4,49] and one on chronic prostatitis/pelvic pain.[45] One study reported that increasing physical activity levels (56.3–92.0 vs. >118 MET-hours/week) offered similar protection against ED when compared to moderate activity levels (OR 0.77 vs. OR 0.78).[4] This finding was like that of a larger retrospective cross-sectional analysis of 20,789 Brazilian men who were moderately active as compared to highly active (OR 0.912 vs. OR 0.849).[49] Pitta and colleagues reported on lower urinary tract symptoms (LUTS) as a risk factor of ED, but not as an independent variable or in relation to exercise or physical activity intensity.[49]

3.5. Dose-dependent relationship

Zhang found that increasing exercise volume reduced risk of males experiencing pelvic pain (OR 0.75 [0.55, 1.03; 95 % CI]). Park et al. reported slight protection against LUTS for those exercising at ⩾1500 MET-minutes per week (HR 0.94 [0.88–1.02], P = 0.03), which has been classified as health-enhancing physical activity.[39] When reporting odds ratios for ED, CP and CPPS, studies identified that higher MET-minutes per week of physical activity were slightly more protective than sedentary or lower levels of physical activity (see Fig. 2). The cross-sectional studies reporting LUTS as a sample percentage identified a dose-dependent relationship between weekly MET-minutes and the prevalence of male LUTS.[40–43,46,47] This relationship was present in both minimum and maximum weighted averages (R = 0.86 vs. R = 0.87) (see Table 5 and Fig. 3).

4. Discussion

Both UI and LUTS were reported in studies reviewing male athletes participating in both high- and low-impact exercises. The prevalence of UI in a weightlifting sample (age: 34.0 ± 13.5) was 9.3 %,[42] and in two studies investigating high-impact sport (track and field) athletes were found to be 17.7 % (age: 22.81 ± 7.26) and 18.8 % (age: 22.38 ± 5.59) respectively.[40,41] This was much greater than the internationally reported average for 20–39-year-olds (average: 2–2.4 %; range: 2–

Table 3
Characteristics of included studies.

Author, year Study design	Participants Age, mean (range)	Pelvic floor dysfunction	Outcome measure	Exercise/Physical activity	Results
Coelho et al., 2022[46] Cross-sectional	N = 103. 30.4 ± 5.2	UI	3IQ	CrossFit ®	N = 4 (3.8 %)
Dominguez-Antuña et al., 2022[47] Cross-sectional	N = 255 34.35 ± 9.09	UI	ICQ-UI-SF[a]	CrossFit ®	N = 16 (6.27 %) reported UI (n = 15 urge UI; N = 1 mixed UI)
Fergus et al., 2019[4] Cross-sectional[b]	N = 3906 Median (41–45)	ED	SHIM	Cycling, running, swimming, multiple	56.3–92.0 MET-hours/wk: OR 0.77[c] (0.61–0.97, 95 % CI) (P = 0.03) 92.1–117.9 MET-hours/wk: OR 0.81[c] (0.64–1.03, 95 % CI) (P = 0.08) >118 MET-hours/wk: OR 0.78[c] (0.62–0.99, 95 % CI) (P = 0.04)
Park et al., 2018[39] Cohort	N = 69,795 HEPA = 11,891 40.7 ± 7.6	LUTS	IPSS	Undisclosed PA[d]	HEPA: HR 0.94 (0.88–1.02) (P = 0.03)
Pitta et al. 2022[49] Cross-sectional	N = 20,789 50.06 ± 7.52	ED	IIEF-5	Undisclosed PA[d]	Low active: OR 0.771 (0.685–0.868, 95 % CI) (P < 0.001) Moderately active: OR 0.912 (0.816–1.019, 95 %) (P = 0.103) High active: OR 0.849 (0.724–0.995, 95 % CI) (P = 0.044)
Rodríguez-López et al., 2022[41] Cross-sectional	N = 128 22.38 ± 5.59	UI	ICQ-UI-SF[a], 3IQ[a], ISI[a]	Track & field: sprints/hurdles, middle distance running, long distance running, athletic walk, horizontal jumps, vertical jumps, throws, & combined events	N = 24 (18.8 %) reported UI. N = 9 (37.5 %) reported leakage during sport training: running (44.4 %); powerlifting tasks (22.2 %); or combined exercises (33.4 %).
Rodríguez-López et al., 2021[40] Cross-sectional	N = 299 22.81 ± 7.26	UI	ICQ-UI-SF[a], 3IQ[a], ISI[a]	38 sports, including: athletics (45.9 %), soccer (8.4 %), gymnastics (7 %)	N = 44 (17.7 %)
Skaug et al., 2022[42] Cross-sectional	N = 204 34.0 ± 13.5 (18–84)	AI, UI	ICIQ-UI-SF, ICIQ-B	Olympic weightlifting, powerlifting	UI N = 19 (9.3 %) [SUI N = 2 - reported during weightlifting, no negative effect reported] AI N = 126 (61.8 %).
Toprak Çelenay et al., 2021[43] Cross-sectional	N = 59 20.0 (18–32)[e]	LUTS	ICIQ-MLUTS (Turkish version)	Basketball, football (soccer), volleyball	ICIQ-MLUTS: Voiding: incomplete emptying 7/59 (11.9 %); Storage: urgency 5/59 (8.5 %); PMD 4/59 (6.8 %); Daytime frequency: 7–8 times 18/59 (30.5 %); 9–10 times 4/59 (6.8 %); Nocturia: once 8/59 (13.6 %); twice 4/59 (6.8 %).
Zhang et al., 2015[45] Cohort	N = 20,918 50.7	CP/CPPS	NIH-CPSI	Jogging, running, lap swimming, tennis, squash, racquetball, rowing, callisthenics	OR 0.75 (0.55, 1.03; 95 % CI) (P for trend = 0.02)

AI = anorectal incontinence; CI = confidence interval; CP = chronic prostatitis; CPPS = chronic pelvic pain syndrome; ED = erectile dysfunction; HEPA = health-enhancing physically active; hr(s) = hour(s); HR = hazard ratio; ICIQ-B = International Consultation on Incontinence Questionnaire Anal Incontinence Symptoms and Quality of Life Module for anal incontinence; ICIQ-MLUTS = International Consultation on Incontinence Modular Questionnaire-Male Lower Urinary Tract Symptoms; ICIQ-UI-SF = International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form; IIEF = International Index of Erectile Function; IIEF-SF = International Index of Erectile Function Short Form; IIQ-7 = Incontinence Impact Questionnaire – Short Form; IPAQ = International Physical Activity Questionnaire; IPSS = International Prostate Symptom Score; LUTS = lower urinary tract symptoms; MET = metabolic equivalent of task; NI = no information; NIH-CPSI = National Institutes of Health Chronic Prostatitis Symptoms Index; OR = odds ratio; PA = physical activity; PFD = pelvic floor dysfunction; PFM = pelvic floor muscle(s); PFME = pelvic floor muscle exercise(s); SHIM = Sexual Health Inventory for Men; UI = urinary incontinence.
[a] Validated Spanish version of respective outcome measures used.
[b] Secondary analysis of existing and/or ongoing studies.
[c] Adjusted OR for age, body mass index, diabetes mellitus, exercise type, marital status, alcohol and tobacco use.
[d] Studies utilised the IPAQ where heavy lifting, digging and aerobics were explicitly listed as examples and therefore were able to be manually calculated.
[e] Study reported male and female age median and range together.

25.4 %).[51] Of these three studies, up to 37.5 % of athletes experienced their symptoms during training or competition.[41] A clear inference would be to suggest that high-impact exercise places men at greater risk of UI or LUTS, possibly due to a transient reduction in PFM capabilities in resisting rapid IAP demands from high GRF. However, both studies also reported high frequency of training (4.97 ± 1.33 days[40]; 4.99 ± 1.26 days[41]) and longer training session durations per week (3.07 h ± 1.37[40]; 2.42 h ± 0.82[41]). The reported exercise intensity in these athlete populations was generally higher than the non-athletic populations included within this review. When combined with an

Table 4
Crowe Critical Appraisal Tool[50]: Literature critical appraisal.

Author, year	Preliminaries [/5]	Introduction [/5]	Design [/5]	Sampling [/5]	Data collection [/5]	Ethical matters [/5]	Results [/5]	Discussion [/5]	Total [/40]	Total [%]
Coelho et al., 2022[46]	4	5	3	3	3	4	2	4	28	70
Dominguez-Antuña et al., 2022[47]	5	5	3	3	3	4	4	4	31	78
Fergus et al., 2019[4]	4	5	4	4	4	3	4	4	32	80
Park et al., 2018[39]	4	5	4	4	4	4	4	5	34	85
Pitta et al., 2022[49]	5	5	5	5	4	3	4	4	35	88
Rodríguez-López et al., 2021[40]	4	5	5	5	4	5	4	5	37	92.5
Rodríguez-López et al., 2022[41]	5	5	5	5	4	5	5	5	39	97.5
Skaug et al., 2022[42]	5	5	4	5	4	4	5	5	37	92.5
Toprak Çelenay et al., 2021[43]	4	5	4	4	2	5	5	5	34	85
Zhang et al., 2015[45]	3	5	3	4	2	2	4	5	28	70

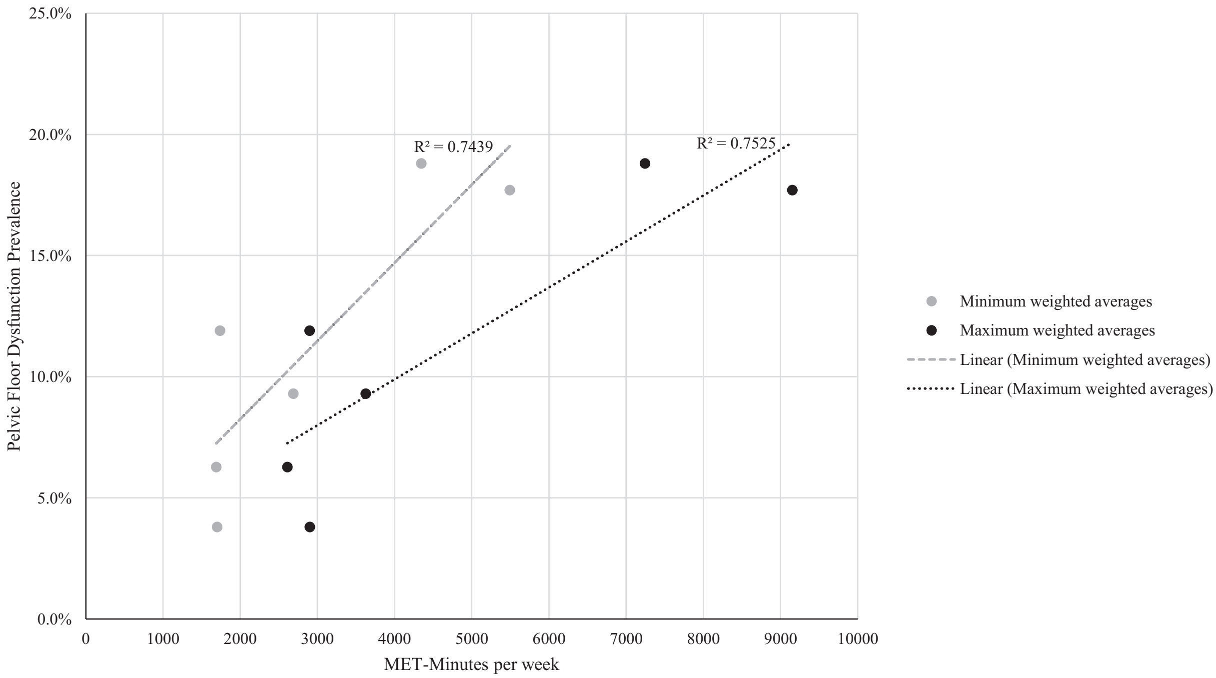

Fig. 2. Scatterplot of studies investigating lower urinary tract symptoms versus minimum and maximum weighted averages of MET-minutes per week.

increase in overall exercise volume (reported as MET-minutes per week), increasing levels appeared to place athletes at much greater risk of UI and LUTS. The comparative analysis of the minimum versus maximum weighted averages of overall MET-minutes per week supports a possible dose-dependent relationship (R = 0.86 vs. R = 0.87).

Further complicating interpretation of these results is the possibility for athletes to be concurrently completing low-impact resistance training which may acutely fatigue the PFM. This limits the ability to assume that PFD is purely resultant from the high-impact aspect of their respective sports, and a cumulative effect induced by both high-impact exercises and low-impact resistance training exercises should be considered as a substantial contributing factor.

Within the included literature, moderate to high levels of exercise and physical activity appear to be protective against ED (n = 2) and pelvic pain (n = 1) when compared to more sedentary levels and expressed as odds ratios. Previous literature supports the notion that this protective response is likely derived from positive systemic changes.[4–6] However, these studies were typically investigating the upper end of physical activity recommendations as a risk factor for ED and pelvic pain, without further consideration given to the substantially higher volumes and intensities of exercise often completed by athletic populations. With such a low number of studies being reviewed, true representation of the influence exercise and physical activity has on ED and pelvic pain requires further investigation. The reported MET-

Table 5
Minimum and maximum weighted averages of MET-minutes per week.

Author, year Study design	Exercise/Physical activity	MET activity value	Minimum MET-minutes per week (where applicable)	Maximum MET-minutes per week (where applicable)
Coelho et al., 2022[46] Cross-sectional	CrossFit ®	8	1704	2904
Dominguez-Antuña et al., 2022[47] Cross-sectional	CrossFit ®	8	1692	2613
Fergus et al., 2019[4] Cross-sectional[b]	Cycling, running, swimming, multiple	11.8	1770	
Park et al., 2018[39] Cohort	Undisclosed PA[a]	≥6	⩾1500 MET	
Pitta et al., 2022[49] Cross-sectional	Undisclosed PA[a]	7	1050	
Rodríguez-López et al., 2022[41] Cross-sectional	Track & field: sprints/hurdles, middle distance running, long distance running, athletic walk, horizontal jumps, vertical jumps, throws, & combined events	6–10	4347	7245
Rodríguez-López et al., 2021[40] Cross-sectional	38 sports, including: athletics (45.9 %), soccer (8.4 %), gymnastics (7 %)	6–10	5493	9155
Skaug et al., 2022[42] Cross-sectional	Olympic weightlifting, powerlifting	6	2691	3629
Toprak Çelenay et al., 2021[43] Cross-sectional	Basketball, football (soccer), volleyball	6–10	1740	2900
Zhang et al., 2015[45] Cohort	Jogging, running, lap swimming, tennis, squash, racquetball, rowing, callisthenics	≥6	2100	

MET = metabolic equivalent of task.
[a] Studies utilised the IPAQ where heavy lifting, digging and aerobics were explicitly listed as examples and therefore were able to be manually calculated.

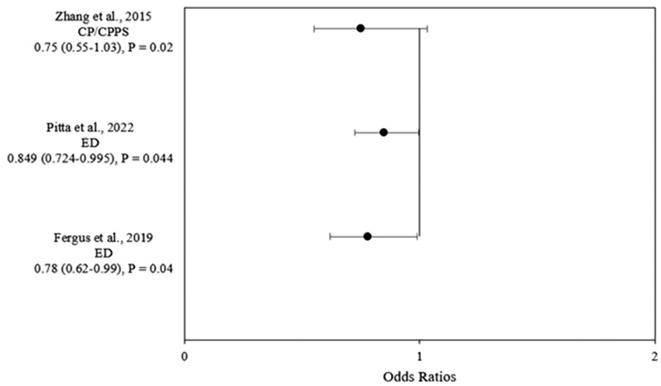

Fig. 3. Forest plot of studies investigating the risk of CP/CPPS and ED associated with exercise.

volumes within the studies investigating ED and pelvic pain populations were likely too low to see any negative effect from exercise – particularly when compared to the MET-volumes of the other included literature. It is probable that male PFM requires greater MET-volumes to produce local fatigue and subsequent erectile dysfunction or pelvic pain resulting from muscular fatigue. Conversely, identifying the role of fatigued PFM in ED may be difficult due to much greater exercise levels being linked with ED resultant from hormonal imbalance or relative energy deficiency.[52]

The measures utilised to diagnose and evaluate male PFD are well established within the literature. However, the complex nature of PFD requires three key considerations: 1) the patient's perspective of both their symptoms and symptom severity; 2) clinician-measured symptom severity; and 3) evaluation of symptoms in broader context of quality of life.[63]

Between 58.8 % and 75 % of male athletes were unaware of both the existence and function of their PFM, highlighting the poor level of knowledge in this area.[42,43] Given that pelvic floor dysfunction may result in a spectrum of symptoms, in-depth exploration may be the first step in recognising concerns at the individual level. All reviewed literature investigated the male's perception of his symptoms, and to a degree the severity. Only Skaug directly measured the degree of bother, specifically the degree brought on from anorectal incontinence.[42] Although AI was the highest reported symptom across included studies within this review (61.8 %), males appear unperturbed by 'accidental' loss of flatus during exercise, reporting very low bother scores.[42] Similar bother scales were not employed when investigating ED, pelvic pain or UI. Zhang failed to report on the quality-of-life domain included within their chosen outcome measure for pelvic pain.[45] This highlights the need to screen for PFD in these populations to determine both the degree of bother and direction for future research. Similarly, Skaug and colleagues were the only research group to investigate concurrent PFD symptoms. The aims and subsequent outcome measures utilised within the literature of this review were focused solely on individual PFDs. Our current understanding of male anatomy suggests that males presenting with one pelvic floor symptom may have, or be at, risk of, multiple conditions associated with the pelvic floor.[19] Without a broader screening tool or greater awareness amongst exercise professionals and researchers, many men may be experiencing co-morbid pelvic health conditions.

5. How is pelvic floor dysfunction investigated in males?

Research in an exercising female population has shown that only one in two exercise professionals screens for the presence of pelvic floor symptoms, and less than a quarter screens when indicated.[64] Under-representation of male health professionals screening for PFD was posited to be due to reduced interest in the area, confidence, or comfort in screening for symptoms.[64] It is suspected that the number of exercise professionals and coaching staff screening an athletic male population is low due to perceptions that males are not at risk. Investigating how and when exercise professionals might screen for pelvic floor symptoms may be the first step in identifying at-risk men who may be at risk of PFD, as well as acknowledging concern of the symptomatic male. This screening may act as a stepping stone for exercise health professionals and coaching staff to consider the tailored management of any pelvic floor dysfunction in conjunction or separate to appropriate training load management.

Objective measurement and screening of male pelvic floor symptoms remains somewhat limited. Pelvic floor muscle activation, control, tone, and length can be measured in multiple ways within the male population. Despite the clinical acceptability of DRE, continued male reluctance exists for internal or more invasive assessments.[65] From both a clinical and research perspective, transperineal real time ultrasound (RTUS) and EMG are becoming common.[16] Transperineal RTUS can show muscular control and contractile patterns (tonic and phasic), with EMG recording electrical potentials generated by muscle fibre membrane depolarisation which can demonstrate localised fatigue.[16]

Realtime ultrasound can also show both ascent and descent of the abdominal cavity during breathing, periods of increased IAP and pelvic floor contraction.[66] Recent preliminary data has identified that the PFM also undergoes length changes during breathing, with these length changes appearing to be independent of IAP changes.[66] From a clinical perspective, this highlights three important considerations. Firstly, that PFM length changes may not exactly equate to muscular activation or force production; secondly, muscle activation versus muscle length may have significant variations between individuals; and lastly, attention to the roles that abdominal muscle contraction, acceleration and breathing have in the given exercise or sport of the individual. As such, both transperineal and EMG are used in diagnosis and rehabilitation and have place in future research investigating how exercise directly influences the male pelvic floor.

6. Possible mechanisms of male pelvic floor muscle dysfunction

High-impact exercise results in increased ground reaction forces, spinal muscular stabilisation and reflexive PFM activation.[20,53] These mediating factors have typically been associated with greater PFD risk due to rapid IAP force production.[20] Recent literature shows that both low- and high-impact activities may have significant IAP increases.[53,54] Weightlifting exercises such as the squat, leg press and deadlift which all require spinal stabilisation result in significant changes to IAP due to abdominal bracing and breath holding.[12,53,55] Increases in exercise intensity or load have also shown to increase IAP, particularly when associated with differences in biomechanics, breathing patterns and muscular recruitment.[54] Through high-impact exercise and subsequent GRF demands, an increase in IAP likely exceeds the capability of local force production or muscular contractile speed to close or maintain closure of the urethral and anal sphincter resulting in PFD symptomology. Progressive resistance training is likely to increase core strength, which would in turn allow an individual to produce greater intra-abdominal forces and stress to the PFM.[2]

A recent study used digital rectal examination (DRE) to explore associations between the male PFM function and pelvic floor symptoms, finding no clear association between the two.[56] Similarly, the absence of pelvic floor symptoms did not consistently indicate normal PFM function.[56] Over a quarter (27 %) of their sample were asymptomatic yet displayed some degree of muscular dysfunction, most commonly with the puborectalis muscle.[56] This is further confounded by 29 % of their sample having had previous pelvic or urological surgeries which are known to alter PFM anatomy and contractile mechanics.[57] Given these limitations, if pelvic floor symptoms were elicited due to local muscular fatigue, it is unlikely to be accurately assessed with DRE. The presence of AI and LUTS during and after exercise clearly suggests that the male pelvic floor musculature cannot always meet the demands placed on it, possibly due to fatigue.[15] Acutely, fatigue has been shown on electromyography (EMG), with PFM fatiguing more quickly than peripheral musculature.[58] Cumulative PFM fatigue may see a temporary reduction of PFM maximal volitional contraction and contractile speed required to maintain continence and sexual function. Thus, it is plausible that acute fatigue experienced by males who train regularly at high intensities for long periods may result in PFM complications.

During rapid IAP increases, the striated urethral sphincter has also been shown to contract prior to loading to presumptively maintain urinary continence.[59] It is possible that through repetitive contraction, an acute fatigue response occurs, influencing force generation and resting tone. The presence of muscular tension may make it more difficult for males to volitionally contract their pelvic floor during periods of increased IAP, such as during sustained or frequent exercise efforts. This increased tone may make it difficult to relax the pelvic floor, which is a function required for normal micturition and defecation without straining.[60,61] Increased resting PFM tone presents as a risk factor for the development of both pelvic pain and sexual dysfunction.[12,61,62] Without clearer understanding of the underlying mechanisms contributing to symptoms, the effect that exercise or physical activity has on pelvic pain warrants further investigation.

7. Limitations

There were substantial variances in method of reporting frequency, intensity, volume, and mode of exercise between included studies. Whilst MET-minutes per week were calculated in an attempt to homogenise exercise reporting for comparative purposes, several limitations should be considered. The calculation is unable to compare reporting of exercise for each variable (e.g., volume, intensity, or mode) between studies. Nonetheless, both minimum and maximum weighted averages were calculated to ascertain the effect of total exercise or physical activity on PFD prevalence. Included studies did not report on any exercise-related variables (e.g., volume, intensity, or mode) amongst participants presenting with PFD.

The mechanisms underlying male pelvic floor fatigue were not investigated in the reviewed literature. Although rapid intra-abdominal pressure changes and greater ground reaction forces were not measured, they have been previously hypothesised to be potential mediating PFD variables that contribute to PFD and should be considered when interpreting these findings.[3] Similarly, the broad range of reported pelvic floor dysfunctions and their respective definitions made for difficult comparison. Consistent use of internationally accepted terminology and PFD screening and diagnostic tools will allow for a clearer understanding of the true prevalence of male pelvic floor dysfunction in exercising populations.

8. Future research

The identification of a dose-dependent relationship between MET-minutes per week and male LUTS indicates that men who engage in high-volume intensive exercise may be at increased risk of symptomology, whereas the risk of ED and CP/CPPS may be mitigated through the systemic effects of exercise.

However, when both intensity and volume are increased, this protective effect of exercise appears to diminish. Growing interest into the impact of exercise on male pelvic floor, particularly regarding the modality of exercise highlights a clear gap in the literature surrounding the physiological mechanisms that contribute to PFD in men. Due to variability in reporting, the specific influence of exercise intensity, volume, and modality remains unclear. Clearer reporting on the frequency, intensity, modality, and duration of exercise sessions is essential.

Future research should consider multiple factors, including the co-occurrence of male PFD, which has been largely overlooked in preference of singular diagnoses. The lack of comprehensive reporting may suggest that the true prevalence of male PFD is underrepresented. Research designs that demonstrate causality may serve to better understand and examine the physiological changes to the male pelvic floor both during and immediately following exercise.

9. Conclusion

This review highlights that athletic males may experience higher rates of LUTS than the general population. It has also identified a dose-dependent relationship between MET-minutes per week and male LUTS, suggesting that higher volumes of intensive exercise may elevate symptom risk, whilst potentially reducing the likelihood of ED and CP/CPPS. However, inconsistent reporting on exercise variables, inclusive of frequency, intensity, modality, and duration, limits interpretability and underscores the need for standardised data collection. The findings advocate for increased awareness and constructive dialogue around male PFD amongst healthcare professionals and athletic coaching staff, as current prevalence rates are likely underestimated due to limited education and recognition.[21] Once prevalence is accurately identified, the importance of manipulating these exercise variables to reduce the risk of PFD becomes paramount.

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CRediT authorship contribution statement

CM is the corresponding author. All authors had access to the data in the review and take responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design: all authors. Acquisition and interpretation of the data: CM. Drafting of the manuscript: CM. Critical revision of the manuscript: all authors. Study supervision: IN, JC, and KD. The corresponding author attests that all listed authors meet the authorship criteria and that no others meeting the criteria have been omitted.

Declaration of interest statement

All authors declare no competing interests.

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