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LITERATURE REVIEW

Elite female athletes' experiences of symptoms of pelvic floor dysfunction: a systematic review

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Abstract

Introduction and aims. Pelvic floor dysfunction (PFD) is a collection of signs, symptoms and conditions affecting the pelvic floor, and urinary incontinence (UI) is the most common type of PFD. Recent systematic reviews have indicated a higher prevalence of UI among female athletes compared to their non-athletic counterparts. To date, no review has been undertaken to investigate female athletes' experiences of PFD. This review aims to offer insight and understanding through aggregation, summary, synthesis and interpretation of findings from studies that report elite female athletes' *experiences* of symptoms of PFD.

Methods. The review protocol was registered in PROSPERO in August 2020. A systematic search was conducted in Embase, MEDLINE (Ovid), the Cochrane Library, CINAHL, PsycINFO and Web of Science for studies published in the English language reporting elite female athletes' experiences of symptoms of PFD. This review included primary research studies that involved elite female athletes of any age or ethnicity.

Results. Of the 1922 citations retrieved in the search, 32 studies met the methodological criteria for data extraction and analysis. Five main themes emerged: (1) triggers for symptoms of PFD; (2) strategies adopted by athletes to manage/mitigate symptoms of PFD; (3) impact on quality of life/daily life; (4) impact on performance; and (5) impact on emotions.

Conclusions. The findings of this review suggest a need to further explore the experiences of PFD among elite female athletes, and it is suggested that future research should adopt qualitative methods or incorporate a qualitative component.

Keywords: elite athletes/sportswomen, experiences, pelvic floor dysfunction.

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Introduction

Pelvic floor dysfunction (PFD) is a collection of signs, symptoms and conditions that affect the pelvic floor (Haylen *et al.* 2010). Urinary

incontinence (UI), the PFD most commonly experienced by women, is defined as a "complaint of involuntary loss of urine" and is a common complaint in women of all ages. The most common types of UI include stress urinary incontinence (SUI) and urge urinary incontinence (UUI). The International Urogynecological Association (IUGA) and the International Continence Society (ICS) define SUI as the "complaint of involuntary loss of urine on effort or physical exertion (e.g., sporting activities), or on sneezing or coughing" and UUI as "complaint of involuntary loss of urine associated with urgency" (Haylen *et al.* 2010). Other symptoms of PFD include anorectal dysfunction (ARD), sexual dysfunction, pelvic organ prolapse (POP) and pelvic pain (Haylen *et al.* 2010; Bø *et al.* 2017). Many women find it embarrassing to discuss symptoms of PFD including continence problems with others, and incontinence has been shown to negatively affect quality of life (Mallah *et al.* 2014; Amaral *et al.* 2015; Pizzol *et al.* 2021).

Mendes *et al.* (2017) conducted a systematic review of qualitative evidence regarding adult women's experiences of UI. Findings from the 28 included studies were grouped into eight themes in the areas of: cultural and religious backgrounds; effect on daily activities/social roles; knowledge and nature of symptoms; experiences of UI and sense of shame; negative effects on intimacy, sexuality and sexual function; UI seen as consequence of pregnancy/childbirth, ageing or religious punishment; strategies adopted by women affected by UI; and meeting of care needs and women's personal preferences. The authors concluded that the preferences and expectations of women with UI should be considered, and that the provision of healthcare should be personal and tailored. A need for additional research to improve the understanding of the impact of UI on the quality of life (QOL) of younger women was identified (Mendes *et al.* 2017).

Urinary incontinence during exercise is not uncommon, and a higher prevalence has been observed among athletes engaged in high-impact sports including running and jumping (Nygaard & Shaw 2016). Rodríguez-López *et al.* (2021) investigated the prevalence of UI in both female and male elite athletes, and found an overall prevalence of 33% (45.1% in females, 14.7% in males) and that, whilst the prevalence of UI was 5.45 times greater in females, elite male athletes were also found to experience UI.

There have been a number of recent systematic reviews concerning PFD in female athletes (de Mattos Lourenco *et al.* 2018; Teixeira *et al.* 2018; Almousa & Bandin Van Loon 2019; Pires *et al.* 2020; Lourenco *et al.* 2021; Rebullido *et al.* 2021). However, the main aim of these reviews has been the investigation of the prevalence of UI in female athletes. Almousa & Bandin Van Loon (2019) included a secondary aim of exploring the knowledge and attitudes of female athletes regarding UI, and de Mattos Lourenco *et al.* (2018) discussed strategies adopted by the athletes to manage their UI. The reviews differ somewhat in their inclusion criteria regarding age and parity, but they all concluded consistently that there was a higher prevalence of UI among female athletes compared to non-athletes. Engaging in high-impact sports (de Mattos Lourenco *et al.* 2018; Almousa & Bandin Van Loon 2019; Pires *et al.* 2020; Rebullido *et al.* 2021) with longer hours of training (Almousa & Bandin Van Loon 2019) appears to be commonly cited as risk factor for UI, but to the present authors' knowledge, no review has been undertaken to investigate female athletes' *experiences* of PFD. Studies have found that experiencing UI during elite sports may be a predictor of UI in later life (Bø & Sundgot-Borgen 2010), and also that elite athletes have been identified as an understudied population in the research into PFD, and in particular, ARD and POP and physical activity (Bø *et al.* 2020).

Whilst a scoping review of the research literature revealed limited qualitative research into the area of PFD among female athletes, such research may, potentially, yield further information regarding the impact of the symptoms of PFD on the female athletes' sporting activities and their daily lives.

Therefore, the present review aimed to offer insight and understanding, through aggregation, summary, synthesis and interpretation of findings from studies that report the experiences of symptoms of PFD in elite female athletes.

Materials and methods

Study design and protocol registration

The present systematic review complied with the adapted PRISMA guidelines for reporting systematic reviews of qualitative and quantitative evidence (Moher *et al.* 2009; Page *et al.* 2021). The review protocol was registered in PROSPERO in August 2020, and is available online (Culleton-Quinn *et al.* 2020).

Search strategy and selection criteria

With the assistance of a medical librarian (D.M.), the electronic databases of Embase, MEDLINE (Ovid), the Cochrane Library, CINAHL, PsycINFO and Web of Science were searched, initially in May 2020 and subsequently in an updated search in January 2022, for studies that reported female athletes' experiences of incontinence/symptoms of pelvic floor dysfunction. The search terms include the following: Wom?n, Femal*, urinar* continen* or incontinen*, Pelvic Organ Prolapse, Urinary leakage, leaking urine, vaginal wind, anal incontinen*, f?ecal incontinen*, Bladder leakage, bowel leakage, Flat* incontinen*, Physical* ADJ (activ* or inactiv* or exercise), recreational* ADJ (activ* or inactiv* or exercise), Exercis* ADJ (strenuous OR vigorous OR moderate), Activit* ADJ (strenuous OR Vigorous OR moderate OR Leisure), sport*, Participat*.ti, ab., Modif*. ti, ab., Stop*.ti, ab., Adapt*.ti, ab., Change*.ti, ab., Limit*. ti, ab., Abandon .ti, ab., Ceas*.ti, ab., Barrier.ti, ab., Impact. ti, ab., Affect.ti, ab.

The present review included primary research studies published in the English language that reported elite female athletes' experiences of symptoms of PFD. The inclusion criteria were: (1) studies that involved female athletes of any age or ethnicity, and studies that included both female and male athletes together when data on female athletes could be extracted; (2) studies involving female athletes who were considered to be at an "elite" level (for the purposes of this review, "elite" could refer to: athletic performance at regional/county/state level; sport/country-specific measures and university/collegiate, international and/or national level; training; professionalism; and involved in talent development); and (3) studies that reported the *experiences* of symptoms of PFD, and how this affects activities of daily living or sporting activity or QOL. This information could be gleaned from questions included in a quantitative survey or qualitative interview-based research. The exclusion criteria were: (1) studies involving only recreational or leisure-time exercisers; (2) editorial opinion articles, letters and commentaries; and (3) studies that did not report on the experiences of symptoms of PFD.

Study selection and assessment of methodological quality

Two reviewers (E.C.-Q. and D.D., or E.C.-Q. and N.F.) independently screened studies using the inclusion/exclusion criteria based on titles, then abstracts and then full texts. Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia; www.covidence.org) was used for the process of screening, and identified agreement between reviewers. Disagreement between two reviewers was resolved by consultation with a third.

Thomas *et al.* (2003) devised a 12-point quality assessment criteria checklist that facilitated assessment of quantitative, qualitative and mixed-methods studies. Subsequently, Panda *et al.* (2018) developed a modified version of this checklist, and this was used to assess the methodological quality of the studies included in the present review. Each criterion was scored "1" if met and "0" if not met, and three categories of methodological quality were identified: "weak" (scores 0–6), "moderate" (scores 7–9) and "strong" (scores 10–12).

Data extraction and data analysis

A double independent data extraction was conducted on the studies selected for inclusion (E.C.-Q. and D.D., or E.C.-Q. and N.F.).

Information was extracted and entered into a pre-designed extraction form in relation to the following study characteristics: authors; and journal, year of study/publication, number of participants, participants' characteristics, description of sport or athletic activity, methods of data collection, data collection instruments/tools, description of symptoms, methods of analysis, and reporting of experiences concerning symptoms of PFD.

Information regarding athletes' experiences of PFD was extracted from closed questions included in validated QOL instruments, from closed questions and open-ended qualitative comments in questionnaires, or from analysis of comments from focus-group interviews.

There was insufficient qualitative information to carry out a meta-synthesis of the findings regarding the reporting of experiences. Thematic analysis occurred by organizing the findings into themes that were tabulated and then further analysed (Braun & Clarke 2006). Descriptive themes were developed. An iterative process was repeated until the themes were considered to be representative and answered the research question.

Results

Selection and quality of the studies

A total of 1922 studies remained after deduplication, 123 were screened at full-text and 32

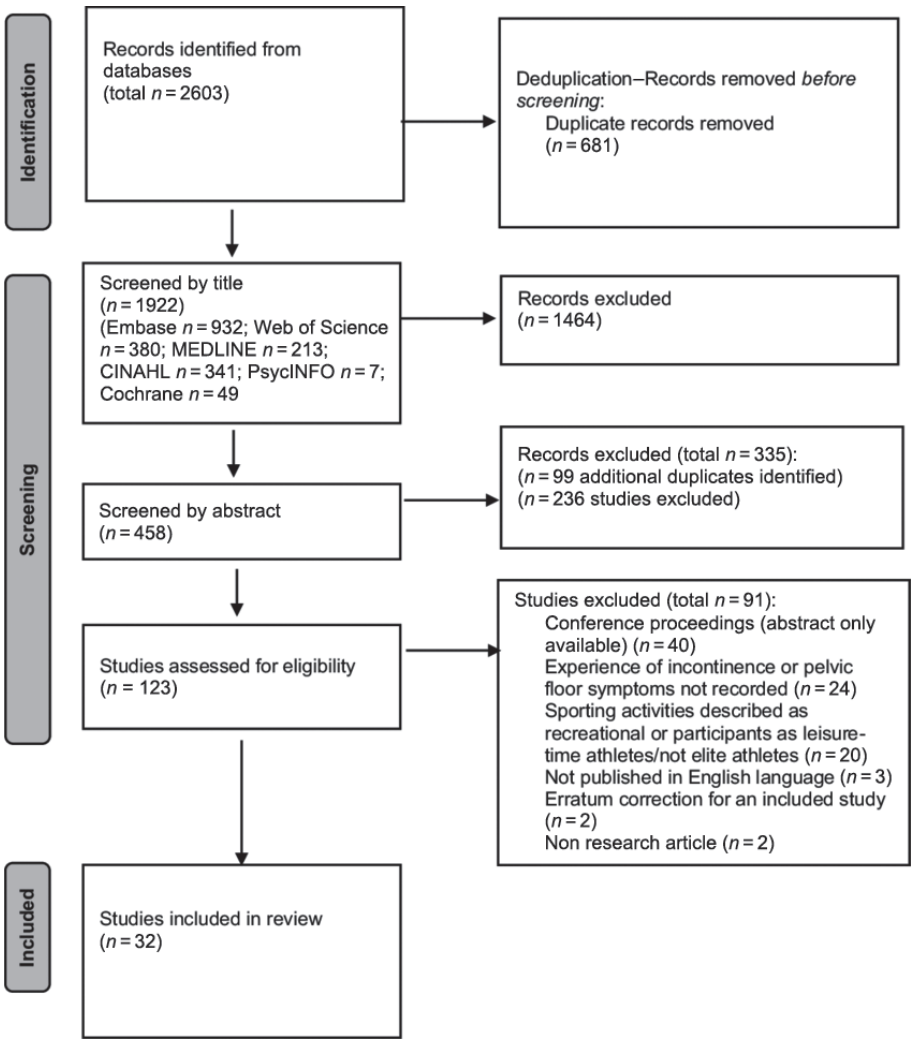

Figure 1. PRISMA flow diagram (Page *et al.* 2021) for included studies.

met the inclusion criteria (Fig. 1). Of these, three studies were of weak quality (Thyssen *et al.* 2002; Carls 2007; Poświata *et al.* 2014), 28 were of moderate quality (Nygaard *et al.* 1994; Nygaard 1997; Eliasson *et al.* 2002, 2008; Caylet *et al.* 2006; Larsen & Yavorek 2006; Dockter *et al.* 2007; Jácome *et al.* 2011; Ferreira *et al.* 2014; Da Roza *et al.* 2015; Almeida *et al.* 2016; Cardoso *et al.* 2018; Carvalhais *et al.* 2018; Hagovska *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Wikander *et al.* 2019, 2020, 2021, 2022; Carvalho *et al.* 2020; Dobrowolski *et al.* 2020; Gram & Bø 2020; Skaug *et al.* 2022a, b; Faulks & Catto 2021; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021) and one was of high quality (Pires *et al.* 2020).

Descriptive analyses of the studies excluding information relating to the reporting of experiences

A summary of the study characteristics *excluding* the reporting of experiences is presented in "Appendix 1" (Table 2). The studies were conducted in 14 countries, and published between 1994 and 2021. Over half of the studies reporting on the experiences of PFD in the present review were published within the past 5 years (56%, 18/32 studies) (Cardoso *et al.* 2018; Carvalhais *et al.* 2018; Hagovska *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Wikander *et al.* 2019, 2020, 2021, 2022; Carvalho *et al.* 2020; Dobrowolski *et al.* 2020; Gram & Bø 2020; Pires *et al.* 2020; Skaug *et al.* 2022a, b; Faulks & Catto 2021; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021). Fifteen studies involved nulliparous participants (Nygaard *et al.* 1994; Eliasson *et al.* 2002; Larsen & Yavorek 2006; Carls 2007; Ferreira *et al.* 2014; Poświata *et al.* 2014; Da Roza *et al.* 2015; Almeida *et al.* 2016; Cardoso *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Hagovska *et al.* 2018; Carvalho *et al.* 2020; Gram & Bø 2020; Pires *et al.* 2020; Sandwith & Robert 2021), and 15 studies included both nulliparous and parous participants (Nygaard 1997; Thyssen

et al. 2002; Caylet *et al.* 2006; Dockter *et al.* 2007; Eliasson *et al.* 2008; Jácome *et al.* 2011; Carvalhais *et al.* 2018; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a; Wikander *et al.* 2020, 2021, 2022; Faulks & Catto 2021; Rodríguez-López *et al.* 2021; Velázquez-Saornil *et al.* 2021). Two studies did not report information on the parity of the participants (Skaug *et al.* 2022b; Wikander *et al.* 2019).

Thirty-one of the 32 studies used a quantitative design, and only one (Jácome *et al.* 2011) used a mixed-methods design (questionnaire and focus group). None of the studies in the present review only used a qualitative design, and there was considerable heterogeneity in study designs. Seven studies utilized purposively designed questionnaires (Nygaard *et al.* 1994; Nygaard 1997; Eliasson *et al.* 2002, 2008; Caylet *et al.* 2006; Dockter *et al.* 2007; Ferreira *et al.* 2014), whilst the remaining 25 used or incorporated validated instruments. The most commonly used survey instrument was the International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form (ICIQ-UI SF), which was used in 13/32 (31%) of the studies (Da Roza *et al.* 2015; Almeida *et al.* 2016; Cardoso *et al.* 2018; Carvalhais *et al.* 2018; Hagovska *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Carvalho *et al.* 2020; Dobrowolski *et al.* 2020; Gram & Bø 2020; Skaug *et al.* 2022a, b; Rodríguez-López *et al.* 2021; Velázquez-Saornil *et al.* 2021).

Urinary incontinence was the most commonly described symptom of PFD, and was reported in all 32 of the studies. Twenty-two studies specifically described the prevalence of UI according to type, with SUI reported as the most prevalent in 21/22 studies (Nygaard 1997; Eliasson *et al.* 2002, 2008; Caylet *et al.* 2006; Larsen & Yavorek 2006; Carls 2007; Dockter *et al.* 2007; Jácome *et al.* 2011; Poświata *et al.* 2014; Almeida *et al.* 2016; Carvalhais *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Carvalho *et al.* 2020; Dobrowolski *et al.* 2020; Gram & Bø 2020; Skaug *et al.* 2022a, b; Faulks & Catto 2021; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021). Mixed urinary incontinence (MUI) was reported as the most prevalent form of UI in one study (Cardoso *et al.* 2018). Anorectal dysfunction was reported in nine studies, with the prevalence of constipation/straining to defecate reported in all of these (Eliasson *et al.* 2008; Da Roza *et al.* 2015; Almeida *et al.* 2016; Carvalhais *et al.* 2018; Carvalho *et al.* 2020; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b; Rodríguez-López *et al.* 2021), and anal incontinence (AI) reported in four (Almeida *et al.* 2016; Carvalho *et al.* 2020; Skaug *et al.* 2022a, b). The prevalence of sexual dysfunction was reported in two studies (Almeida *et al.* 2016; Carvalho *et al.* 2020), the prevalence of POP was reported in four (Larsen & Yavorek 2006; Almeida *et al.* 2016; Carvalho *et al.* 2020; Skaug *et al.* 2022a) and the prevalence of pelvic pain was reported in two (Poświata *et al.* 2014; Sandwith & Robert 2021).

Experiences of pelvic floor dysfunction

Information regarding female athletes' experiences of PFD was extracted from closed questions included in validated QOL instruments, from closed questions and open-ended qualitative comments in questionnaires, and/or from analysis of comments from a focus group. The findings regarding the experiences of the athletes were grouped into five main themes (Table 1) and are summarized below. As previously mentioned, there was insufficient qualitative information to perform meta-synthesis of the findings.

Theme 1: triggers for symptoms of pelvic floor dysfunction

The first theme, triggers for symptoms of PFD, was reported in 30/32 (94%) of the studies. "Competition, training and physical activity" was the most common trigger reported in 26/30 studies (Nygaard *et al.* 1994; Nygaard 1997; Eliasson *et al.* 2002, 2008; Thyssen *et al.* 2002; Caylet *et al.* 2006; Jácome *et al.* 2011; Ferreira *et al.* 2014; Da Roza *et al.* 2015; Almeida *et al.* 2016; Cardoso *et al.* 2018; Carvalhais *et al.* 2018; Hagovska *et al.* 2018; Wikander *et al.* 2019, 2020, 2021, 2022; Dobrowolski *et al.* 2020; Carvalho *et al.* 2020; Gram & Bø 2020; Skaug *et al.* 2022a, b; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021). In 7/26 studies (Eliasson *et al.* 2002; Caylet *et al.* 2006; Jácome *et al.* 2011; Carvalhais *et al.* 2018; Wikander *et al.* 2019, 2020, 2021, 2022), the PFD occurred at the end/latter part of the competition or training session. "Specific movements during activity (sporting and daily life)" was the next most common trigger reported in 16/30 studies (Nygaard *et al.* 1994; Eliasson *et al.* 2002, 2008; Carls 2007; Dockter *et al.* 2007; Jácome *et al.* 2011; Wikander *et al.* 2019, 2020, 2021, 2022; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b; Faulks & Catto 2021; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021). Being "on the

Table 1. Athletes' experiences of pelvic floor dysfunction (PFD): (QOL) quality of life; (UI) urinary incontinence; (SUI) stress urinary incontinence; (ICIQ-UI SF) International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form; (UL) urinary leakage; (IQR) interquartile range; (NR) not reported; (EG) experimental group; (CG) control group; (I-QOL) Incontinence Quality of Life questionnaire; (KHQ) King's Health Questionnaire; (ISI) Incontinence Severity Index; (SD) standard deviation; (AI) anal incontinence; (PFMs) pelvic floor muscles; and (PFMT) pelvic floor muscle training

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Almeida *et al.* (2016)	Type of sport in competition or training: (UI) highest prevalence among the athletes who practiced artistic gymnastics and trampoline (88.9%) (SUI) artistic gymnasts and trampolinists (87%)	48% (32/67) of athletes used strategies to avoid UI "Emptying the bladder before training" was the most reported strategy (31.4%, 10/32)	NR	NR	NR
Cardoso *et al.* (2018)	UI in training (61%, 50/82) UI in competition (45%, 37/82)	Strategies reported included: hydric restriction (15%, 12/82) use of pad (12%, 10/82) sought medical assistance (4%, 3/82) sought physiotherapeutic care (0%) mentioned UI to trainer (0%)	Slight impact, as measured by the ICIQ-UI SF: mean of 1.98 points for impact on QOL	Most athletes did not believe that UI affected their sports performance (no percentage or number given)	NR
Carls (2007)	Type of movement/activity in sport (numbers unspecified): sports (14%) exercises (11.6%) jumping (6.9%) weightlifting (2.3%) coughing (11.6%) sneezing (6.9%) walking to bathroom with a strong urge (11.6%) hearing running water with urge (4.7%)	8% reported avoiding hobbies, social activities, sports and exercises because of their SUI The majority of athletes with UI did not speak to anyone about SUI (92%)	16% with UI reported a negative effect on their social life, sports or exercise	NR	NR
Carvalhais *et al.* (2017)	UI in training (74.5%, 82/110): 84.1% (69/82) reported that it happened at the middle/end of training	14.6% (12/82) of athletes with UI used strategies to "reduce visible leakage" 75% (9/12) of those that used strategies reported wearing pads	NR	39.1% (32/82) considered that UI affected sports practice	NR
Carvalho *et al.* (2020)	Of the cheerleaders who reported UI, 47.6% (10/21) reported UI during training	NR	NR	NR	NR
Caylet *et al.* (2006)	UI in training (34.1%, 15/44): 86.67% (13/15) reported that it happened only in the second part of training UI in the second part of competitions (38.6%, 17/44): 58.8% (10/17) reported that it only happened in the second part of competitions	Majority of athletes did not speak to anyone about UI (84%, 37/44) Spoke to: trainer (0%) family doctor (2.2%, 1/44) sports doctor (2.2%, 1/44) family member (11.3%, 5/44)	NR	NR	NR

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Da Roza *et al.* (2015)	UI in training (72.7%, 16/22): all incontinent women stated that UL started only *after* they began trampoline training Positive association observed between higher ranking in the national championship and ICIQ-UI SF score ($r = 0.573$, $P = 0.05$)	NR	Overall impact of UI on QOL was self-reported as "not interfering" or "interfering mildly" by 68.8% (11/16) of the incontinent athletes Only one athlete reported that loss of urine had a great effect on her daily life	NR	Athletes with higher training volumes felt more embarrassment and discomfort with urine leakage (no percentage or number given)
Dobrowolski *et al.* (2020)	Competition and training (percentages and numbers unclear): SUI occurred most often among these athletes when performing "double-unders" (67%, 36/54) and "triple-unders" (86%, 48/56)	Strategies used by retired athletes with UI during rope-skipping (survey 2): voiding before events (72%, 46/64) voiding between events (71%, 45/63) using containment (e.g. pads or tampons) (38%, 24/63) limiting fluid intake (20%, 12/61) sought treatment for UI (0%) only one female athlete identified that SUI was one of eight reasons for retiring from rope-skipping	The median ICIQ-UI SF score in incontinent athletes was 4 (IQR = 3–6), indicating a slight impact of UI on their overall QOL	Some athletes stopped participating in "double-under" and "triple-under" events because SUI affected their performance Attrition from participation in "double-unders" and "triple-unders" as a result of SUI was 6% in competition and 16% in practice	NR
Dockter *et al.* (2007)	UI when coughing, sneezing and/or laughing: 16.5% (18/109) reported "sometimes" or "frequently" During physical exertion (e.g. lifting, running, jumping and abrupt movements): 16.5% (18/109) reported "sometimes", "often" or "always" Urge-to-void UI (problem on way to toilet) (10.1%, 11/109)	Prevention strategies used by 38.53% (42/109): increase frequency of urination/go before event/run to bathroom (42.85%, 18/42) holding urine or avoiding laughing (16.67%, 7/42) doing nothing to prevent leakage (30.95%, 13/42) other (not defined) (9.52%, 4/42)	NR	NR	NR
Eliasson *et al.* (2002)	Leakage during jumping: answered by 21 participants, mainly "at end of exercise session" (47.6%, 10/21) New, strenuous and difficult exercises reported as triggers for UI (38.1%, 8/21) UI reported occurring "in double somersaults" (23.8%, 5/21) Women in the leakage group had been training longer ($P < 0.04$) and more frequently ($P < 0.03$)	Strategies used by those with UI: protective pads (82.1%, 23/28, with 12/23 of these always) frequent toilet visits (numbers not specified) limiting fluid intake (numbers not specified)	NR	NR	Athletes reported that they were embarrassed, and considered the leakage a social or hygiene problem (51.4%, 18/35); 61.1% (11/18) were "very embarrassed"

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Eliasson *et al.* (2008)	Some athletes connected leakage with specific exercises (e.g. high jumps or somersaults, especially double ones) (28%, 39/138) Athletes reported that UI occurred more often during training ($P = 0.022$) Coughing, laughing (numbers not specified) On way to the toilet (numbers not specified) During other physical activities (numbers not specified)	78% (45/58) of athletes in the competitive group used sanitary pads, which was significantly more than the recreational group (43%, 34/80) ($P < 0.001$) 72% (99/138) of athletes in both groups had discussed their leakage with someone, most of them with their friends, team coach or parents	When experiencing UI during trampolining, 36% (20/85) of competitive athletes were affected in their daily life 61% (31/85) were affected psychologically	12% (16/133) of athletes in both groups had stopped trampolining as a result of the leakage	NR
Faulks & Catto (2021)	Type of activity in sport: being tackled (67%, 26/39) sprinting (61%, 24/39) jumping (54%, 21/39) making a tackle (49%, 19/39) changing direction while running (39%, 15/39) jogging (33%, 13/39) grappling or wrestling (31%, 12/39) scrummaging (28%, 11/39) lifting (23%, 9/39) throwing (21%, 8/39) catching (18%, 7/39)	NR	NR	28% (11/39) reported the effect of SUI on performance during games or training 5% (2/39) reported SUI as barrier to playing rugby union in the future	NR
Ferreira *et al.* (2014)	Training: EG (87.5%, 14/16) CG (81.3%, 13/16) Competition: EG (12.5%, 2/16) CG (18.8%, 3/16)	Wearing protective pads: EG (68.8%, 11/16) CG (68.8%, 11/16) Going to the bathroom prior to sport: EG (87.5%, 14/16) CG (100%, 16/16) Reducing fluids prior to sport: EG (56.3%, 9/16) CG (50.0%, 8/16)	NR	NR	NR
Gram & Bø (2020)	34 and 21 athletes reported UI and SUI, respectively For those with SUI: physical activity (57.1%, 12/21) coughing and sneezing (9.5%, 2/21)	NR	Mild: mean ICIQ-UI SF score for UI interfering with daily life was 1.2 (SD = 1.1)	70.6% (24/34) gymnasts with UI reported that it had some affect om performance	Of the 34 gymnasts with UI, 29.4% (10/34) reported that they were afraid of visible leakage, and 14.7% (5/34) were worried that leakage would happen again

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Hagovska *et al.* (2018)	Slight UI on physical activity for 6.14% of sportswomen (numbers not specified)	NR	Significant negative correlation was observed between SUI and the overall I-QOL score ($r = 0.522$, $P < 0.001$)	Affected sports performance: significantly worse parameters were recorded ($r = 0.648$, $P < 0.001$) on the I-QOL avoidance and limiting behaviour subscales	Embarrassment: significantly worse parameters recorded on the I-QOL in psychosocial impact and social embarrassment subscales ($P < 0.001$)
Jácome *et al.* (2011)	Questionnaire (41.5%, 44/106): urgent need to go to the bathroom (43.1%, 19/44) coughing (38.6%, 17/44) practicing sport (36.4%, 16/44) sneezing (31.8%, 14/44) laughing (31.8%, 14/44) Focus group: activities requiring physical effort jumping	In the questionnaire, 38.6% discussed their leakage with: a friend (20.4%, 9/44) a relative (11.4%, 5/44) a health professional (4.5%, 2/44) the team coach (2.3%, 1/44) Focus group: restriction of liquids preventative urination performance of physical activities in restricted way no athlete had sought help for UI from a health professional	Despite their concerns about UI, athletes in the focus group stated that the condition had no current impact on their daily lives	Athletes in the focus group stated that UI affected sports performance, and resulted in "performance of physical activities in a restricted way"	When urine loss occurred, athletes in the focus group (numbers not specified) reported being: concerned annoyed frustrated fearful "that a new activity might trigger another leakage"
Larsen & Yavorek (2006)	NR	Only one woman reported using pads because of UI (3.6%, 1/28)	None of the women felt that urine loss constituted a problem	NR	NR
Lúðvíksdóttír *et al.* (2018)	Coughing and sneezing (numbers not specified)	NR	11/18 athletes with UI Disturbed Daily Life scale: 0–10 (36.4%, 4/11) no disturbance (63.6%, 7/11) Score ≤ 5	NR	NR
Nygaard *et al.* (1994)	UI: practice (16%, 23/144) competition (16%, 23/144) Type of movement/activity in sport: jumping/legs apart (30%) jumping with legs together (28%) running (30%) impact on floor during dismount/ after flips (14%) Daily activities (excluded leaking "rarely"): coughing (15%) sneezing (6%) heavy lifting (3%) walking to the bathroom (29%) sleeping (6%) on hearing running water (11%)	Only one woman stated that she wore a pad because of the urine loss Discussed their leakage (numbers not specified) Almost half of the athletes discussed their UI with a teammate $< 5\%$ had discussed their UI with a trainer, coach, physician, nurse or family member	NR	NR	38% of the athletes felt embarrassed 22% described anxiety 6% expressed fear about the condition (numbers not specified)

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Nygaard (1997)	During Olympic sport: high impact (35.8%, 19/53) low impact (4.5%, 12/44)	Strategies during Olympic activity not recorded Current strategies: three of the high-impact athletes and one of the low-impact athletes wore a pad daily (numbers not specified) Discussed their leakage: four athletes sought medical treatment for UI (numbers not specified)	NR	Affected sports performance (currently): athletes stopped an activity because of UI (numbers not specified)	NR
Pires *et al.* (2020)	Coughing sneezing and running (as per KHQ, Part II, Q5): 69.2% (9/16) of all athletes (both CG and EG)	NR	High QOL in participants: pre-intervention, the mean global score on the KHQ was low in both groups (CG: 8.80 ± 4.62; EG: 6.35 ± 5.19), indicating high QOL	Bladder problem affecting physical activities pre-intervention: 69.2% (9/13) responded "a little" and 7.7% (1/13) "moderately"	NR
Poświata *et al.* (2014)	NR	NR	Scale from 0–100, the degree to which the respondents found the UI symptoms bothersome (numbers not specified): not bothered (29.46%) slightly bothered (42.86%) moderately bothered (18.75%) significantly bothered (8.04%) heavily bothered (0.89%)	NR	NR
Rodríguez-López (2021)	Trigger for leakage while training: lifting weights (9%, 14/156) running (19.2%, 30/156) after running (4.5%, 7/156) jumping (43.6%, 68/156) after jumping (2.6%, 4/156) trunk rotation (1.3%, 2/156) forward flexion (0.6%, 1/156) In female athletes, there was a weak correlation between UI and days of training per week ($r = 0.104$; $P = 0.028$)	NR	ISI scores reported for female athletes with UI: severe (3%, 5/168) moderate (28.6%, 48/168) slight (68.5%, 115/168)	NR	NR

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Sandwith & Robert (2021)	Rugby game competition (90%, 46/51) Type of movement/activity in sport: tackled/hit (88%, 45/51) running (41%, 20/51) weight training (18%, 9/51) Athletes who leaked urine reported more hours of training per week ($P = 0.008$) For every additional hour of training, the risk of UI increased by 15.3% (95% confidence interval = 2.9–29.3%)	None of the athletes mentioned the use of any incontinence products or pads during exercise Only one had discussed her UI with a health professional None of had received any treatment for UI Several (18%, 9/51) were interested in receiving treatment for their UI	Players who reported that UI was "not a problem/ only a small problem": rugby game competition (100%, 46/46) tackled/hit (98%, 44/45) running (41%, 20/20) weight training (100%, 9/9)	NR	NR
Skaug *et al.* (2022a)	Type of movement/activity in sport: heavy lifting (1–5 repetition maximums) (78%, 64/82) deadlift (63%, 52/82) squat (56%, 46/82) weightlifting with belt (34%, 28/82) clean lift (13%, 11/82) weightlifting (> 6 repetitions) (12%, 10/82) power/explosive training (12%, 10/82) bench press (2%, 2/82) snatch lift (1%, 1/82) Most women with SUI reported UI during training (91.5%, 75/82), and more than half during competition (56.1%, 46/82) Body mass index was the only factor found to have a significant positive association with SUI Triggers for AI during training and competition: gas AI (89.1%, 123/138) liquid AI (23.8%, 14/59) solid AI (15.4%, 2/13) An international level of competition was positively associated with AI Weightlifting training of < 4 days per week had a significant negative association with AI	54.9% (45/82) reported using pads to protect against visible leakage, and 7.3% (6/82) used intravaginal tampons 86.6 (71/82) voided before training or competition 13.4% (11/82) decreased fluid intake 19.5% (16/82) reported that they would occasionally avoid training or specific exercises because of UL 25.6% (21/82) had never discussed their condition with anyone 42.8% (77/180) did not know why they should train their PFMs and 44.4% (80/180) did not know how to do this 78.3% (141/180) women responded they would do PFMT to prevent or treat PFD if they knew how	ICIQ-UI SF: the mean impact of UI on daily activities was 1.8 (SD = 2.0, range = 0–9), with 11 (12.2%) scoring ≥ 5 Of women reporting AI, the mean bother of accidental loss of gas, liquid and solid stool was 2.3 (SD = 2.5, range = 0–9), 2.0 (SD = 2.5, range = 0–9) and 2.2 (SD = 2.8, range = 0–9), respectively The percentage of women scoring ≥ 5 on bother was: gas AI (15.9%, 22/138) liquid AI (15.3%, 9/59) solid AI (15.4%, 2/13)	87.8% (72/82) of those with SUI reported a negative effect of UI on sports performance	Impact of SUI: loss of concentration (51%, 42/82) fear of visible leaking (59%, 48/82) fear of urine odour (34%, 28/82) embarrassment (33%, 27/82) negative effect on performance (27%, 22/82) feeling frustrated, annoyed or worried (24%, 20/82) fear of leakage happening (23%, 18/82) making more mistakes (13%, 11/82)

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Skaug *et al.* (2022b)	The proportion of athletes with SUI was significantly lower in cheerleaders compared to artistic and team gymnasts ($P < 0.001$) Type of movement/activity in sport: running (4%, 8/201) jumping (50%, 101/201) take-off to a gymnastic or acrobatic element (67%, 135/201) land from a gymnastic or acrobatic element (60%, 121/201) in air during a gymnastic or acrobatic element (13%, 26/201) trampoline or trampolette (51%, 103/201) Most athletes with SUI reported leakage during training (98%, 198/201) 44.8% during competition (90/201) Years of specialization in gymnastics/cheerleading was the only variable found to be positively associated with AI In training and/or competition, 87.6% (227/259) reported gas AI: rarely (38.2%, 99/259) occasionally (35.1%, 91/259) often (12%, 31/259) all the time (2.3%, 6/259) In training and/or competition, 22.3% (29/130) reported liquid AI: rarely (18.5%, 24/130) occasionally (3.8%, 5/130) In training and/or competition, all reported experiencing solid AI rarely (17.9%, 7/39)	28.4% (57/201) reported using pads to protect against visible leakage, and 4.5% (9/201) used intravaginal tampons 66.7% (134/201) pre-voided before training/competition 8.5% (17/201) decreased fluid intake 22.4% (45/201) reported that they would occasionally avoid training or specific exercises because of UL 26.4% (53/201) had never spoken about UI Discussed UI with: coach (6.5%, 13/201) healthcare personnel (6.0%, 12/201) teammates (57.2%, 115/201) friends (37.8%, 76/201) parent (19.9%, 40/201) PFMT: did or had tried PFMT (0.9%, 3/319) had never heard about the PFMs (41.4%, 132/319) would do PFMT to prevent or treat PFD if they knew how (73.7%, 230/319) Athletes had heard about the PFMs from: coach (12.2%, 39/319) teammates (10%, 32/319) health personnel (19.1%, 61/319) other sources (i.e. friends, siblings or parents) (16.9%, 54/319) The mean self-rated knowledge of the PFMs of 10 was 1.5 (SD = 1.7) Thirty-two (10.0%) knew how to train the PFMs, and 58 (18.2%) knew why to do so	ICIQ-UI SF: the mean impact of UI on daily activities was 2.5 (SD = 2.4, range = 0–10), with 46 (21.4%) scoring ≥ 5 Of females reporting AI, the mean bother of accidental loss of gas, liquid and solid stool was 3.0 (SD = 2.6, range = 0–10), 2.3 (SD = 2.3, range = 0–10) and 2.4 (SD = 2.4, range = 0–10), respectively Athletes scoring ≥ 5 on bother: gas AI (26.6%, 69/259) liquid AI (15.4%, 20/130) solid AI (15.4%, 6/39)	82.6% (166/201) of those with SUI reported that UI had a negative effect on sports performance	Fear of visible leaking (66%, 133/201) Embarrassment (65%, 131/201) Fear of urine odour (51%, 103/201) Fear of leakage (39%, 78/201) Loss of concentration (31%, 62/201) Feeling frustrated, annoyed or worried (29%, 58/201) Negative effect on performance (18%, 9/201) Making more mistakes (11%, 22/201) Fear of bowel leakage happening (49%, 13/201) Athletes reported that they sometimes or more often were worried about bowel leakage
Thyssen *et al.* (2002)	UI: training (95.2%, 119/125) competition (51.2%, 64/125)	60.2% (91/151) occasionally wore a pad/shield 6.6% (10/151) reduced liquid intake Only 3.3% (5/151) discussed UL with their doctor 4.6% (6/151) had completed a PFMT programme because of UI	33.8% (51/151) considered UL a problem 21.1% (32/151) considered UI a hygienic problem	NR	NR

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Velázquez-Saornil *et al.* (2021)	Leakage caused by exercise or physical exertion (64.3%) No significant relationship between UI and sporting discipline Greatest number of athletes with UI practice long-distance running, who represent 32.1% of all women experiencing UI Athletes taking part in jumping events reported the lowest rates of UI (10.7%)	Use of pad: use protection (58.6%, 17/28) wet their underwear (39.3%, 11/28)	0% of athletes considered that UI affected their daily life	46.4% (13/28) were affected in their sporting environment	Anxiety/depression (14.3%, 4/28)
Wikander *et al.* (2019)	UI in training and competition lifts (numbers not specified, but voluntary comments by 27 women) Type of activity in sport: deadlifts (40.7%, 11/27) squats (18.51%, 5/27) front squats (7.4%, 2/27) wearing a belt when lifting (18.51%, 5/27) end of sets (14.8%, 4/27) UI with moderate to heavy weights: heavier weights (51.9%, 14/27) UI with very heavy/maximal weights Activity outside sport: jumping (14.8%, 4/27) sneezing (7.4%, 2/27)	PFMT (7.4%, 2/27) Not wearing a belt (7.4%, 2/27) Prophylactic voiding (11.1%, 3/27) Improving diet (3.7%, 1/27)	NR	NR	NR
Wikander *et al.* (2020)	UI: training (37.4%, 169/452) competition (32.1%, 145/452) training and/or competition, as well as daily life (38.3%, 173/452) training and/or competition, but not in daily life (17.7%, 80/452) Activities most likely to cause UI: jumping rope (39.16%, 177/452) "double-unders" (36.95%, 167/452) trampoline (25.00%, 113/452) running/jogging (20.57%, 93/452) Activities least likely to provoke UI: low-impact body weight activities such as lunges UI during high-repetition sets (28.7%, 60/208) UI most likely to occur at the end of high-repetition sets (50%, 30/60) UI during heavy sets (28.2%, 59/208)	PFMT: 73.6% (153/208) of participants who had experienced UI at some point had never undergone a pelvic floor assessment. 26% (54/208) of women who reported UI at some point in their life were not confident in their ability to correctly perform PFM exercises	NR	NR	NR

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Wikander *et al.* (2021)	23.1% (111/480) had experienced "athletic incontinence" during training and competition 17.9% of women (86/480) who had been continent before commencing powerlifting now experienced UI during training or competition, but not during everyday activities (Type 1 athletic incontinence) 5.2% (25/480) had experienced UI before commencing powerlifting, but are now continent during everyday activities while continuing to experience UI during training or competition (Type 2 athletic incontinence) UI during maximum lift attempts: training (40.4%, 194/480) competition (30.6%, 147/480) UI during sumo deadlifts (12.5%, 60/480) UI during high repetition sets (35.2%, 169/480) UI worse at end of session (64.5%, 109/169) UI was only an issue if the sets were heavy (79.3% 134/169)	Strategies to control or minimize UI listed under the following headings (numbers not specified): "Bracing related", modifying technique ± belt use ± PFMT "Preparation/setup related", blowing/ exhaling prior to lift, pelvic floor lift, dynamic warmup/post-workout stretching routine "Pelvic floor related", PFMT, pre-contraction of PFMs "Technique/form/breathing related", exhaling during lift, ribcage positioning, bracing PFMs "Other training related", avoid wearing belt, frequent voiding, fluid restriction, take spare underwear to gym and competitions "General", wear protection, physiotherapy treatment/PFMT/ stretching/relaxation and massage, transcutaneous electrical nerve stimulation, core exercises, avoid straining/certain activities/laughing, reducing caffeine Sought treatment: 20.9% (49/234) of participants with UI had undergone a pelvic floor assessment PFMT: 71.71% (344/480) of participants stated that they were either confident/ very confident regarding their PFMT	NR	NR	NR

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Table 1. (*Continued*)

Study	Triggers for symptoms of PFD	Strategies adopted by athletes to manage/ mitigate symptoms of PFD	Impact on QOL/daily life	Impact on performance	Impact on emotions
Wikander *et al.* (2022)	16.2% (31/191) of weightlifters reported "Type 1 athletic incontinence": competition (17.8%, 34/191) training (25.7%, 49/191) UI: during high-repetition sets (57.1%, 40/70) during maximum effort lift in training (24.6%, 47/191) during maximum effort lift in competition (16.8%, 32/191) provoked by wearing a belt (3.7%, 7/191) 67.5% (27/40) of these women indicated that leakage was only an issue if the sets were heavy 50% (20/40) who experienced UI during high-repetition sets stated that leakage was more likely to occur at the end	Antibiotics for recurring urinary tract infections, yoga and Pilates, emptying bladder before training, and frequent urination during training sessions/ competitions Engaging the PFMs before lifting Focusing on breathing, bracing core before lifts, trying to not overbrace, wearing a pad, using a tampon or avoiding the use of tampons, practicing PFM exercises outside training, release work/massage, focus on pelvic mobility, core training, not overtightening belt, wearing dark-coloured clothing, maintaining a low body mass, and crossing legs before sneezing 24.3% (17/70) of the participants with UI had undergone a pelvic floor assessment PFMT: 77.1% (54/70) of the participants with UI stated that they were confident/ very confident in their ability to perform PFM exercises	NR	NR	NR

way to toilet/sudden need to go to toilet" was reported as a trigger in 5/30 studies (Nygaard *et al.* 1994; Carls 2007; Dockter *et al.* 2007; Eliasson *et al.* 2008; Jácome *et al.* 2011), suggesting symptoms of MUI.

Theme 2: strategies adopted by athletes to manage/mitigate symptoms of pelvic floor dysfunction

The second theme, strategies adopted by athletes to manage/mitigate symptoms of PFD, was reported in 23/32 (72%) of the studies. The "use of pads/containment strategies" was the most commonly identified strategy in 16/23 of the studies (Nygaard *et al.* 1994; Nygaard 1997; Eliasson *et al.* 2002, 2008; Thyssen *et al.* 2002; Larsen & Yavorek 2006; Ferreira *et al.* 2014; Cardoso *et al.* 2018; Carvalhais *et al.* 2018; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021; Wikander *et al.* 2021, 2022). Fourteen of the 23 studies found that athletes "discussed condition with others/sought help". However, very few participants discussed/sought help for their PFD with a health professional (Nygaard *et al.* 1994; Nygaard 1997; Thyssen *et al.* 2002; Caylet *et al.* 2006; Carls 2007; Eliasson *et al.* 2008; Jácome *et al.* 2011; Cardoso *et al.* 2018; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b; Sandwith & Robert 2021; Wikander *et al.* 2021, 2022). "Increased frequency of urination/pre-voiding/voiding during events" were strategies adopted by athletes in 10/23 of the studies (Eliasson *et al.* 2002; Dockter *et al.* 2007; Jácome *et al.* 2011; Ferreira *et al.* 2014; Almeida *et al.* 2016; Wikander *et al.* 2019, 2021; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b) and "fluid restriction" was reported in 9/23 (Eliasson *et al.* 2002; Thyssen *et al.* 2002; Jácome *et al.* 2011; Ferreira *et al.* 2014; Cardoso *et al.* 2018; Dobrowolski *et al.* 2020; Skaug *et al.* 2022a, b; Wikander *et al.* 2021). "Modification or avoidance of certain activities/movements" was reported in 7/23 of the studies (Carls 2007; Jácome *et al.* 2011; Wikander *et al.* 2019, 2021, 2022; Skaug *et al.* 2022a, b). Pelvic floor muscle (PFM) exercises/training (PFMT) was a strategy used by participants in 7/23 of the studies (Thyssen *et al.* 2002; Wikander *et al.* 2019, 2020, 2021, 2022; Skaug *et al.* 2022a, b).

Theme 3: impact of pelvic floor dysfunction on quality of life/daily life

The third theme, impact on QOL/daily life, was reported on in 18/32 (56%) of the studies. The findings were diverse. Hagovska *et al.* (2018) described a significant negative correlation between athletes' prevalence of SUI and overall Incontinence Quality of Life (I-QOL) questionnaire score, and Eliasson *et al.* (2008) reported that, as a result of their PFD, 36% (20/85) of the trampolinists in their study were affected in their daily lives and 61% (31/85) were affected psychologically. However, the majority of the studies (16/18) reported that, for most of the participants, PFD did not have a marked impact on the athletes' QOL/daily life (Thyssen *et al.* 2002; Larsen & Yavorek 2006; Carls 2007; Jácome *et al.* 2011; Poświata *et al.* 2014; Da Roza *et al.* 2015; Cardoso *et al.* 2018; Lúðvíksdóttír *et al.* 2018; Dobrowolski *et al.* 2020; Gram & Bø 2020; Pires *et al.* 2020; Skaug *et al.* 2022a, b; Rodríguez-López *et al.* 2021; Sandwith & Robert 2021; Velázquez-Saornil *et al.* 2021).

Theme 4: impact on performance

The fourth theme, impact on performance, was reported in 12/32 (38%) of the studies. One reported that PFD "did not impact performance" (Cardoso *et al.* 2018). The remaining 11/12 of the studies reported that PFD had an "effect on some of the athletes' performance" (Eliasson *et al.* 2008; Jácome *et al.* 2011; Carvalhais *et al.* 2018; Hagovska *et al.* 2018; Dobrowolski *et al.* 2020; Gram & Bø 2020; Pires *et al.* 2020; Skaug *et al.* 2022a, b; Faulks & Catto 2021; Velázquez-Saornil *et al.* 2021), and six of these reported that some athletes had stopped an activity or limited their behaviour/activity in their sport (Nygaard 1997; Eliasson *et al.* 2008; Jácome *et al.* 2011; Hagovska *et al.* 2018; Dobrowolski *et al.* 2020; Faulks & Catto 2021).

Theme 5: impact on emotions

The fifth and final theme, impact on emotions, was reported in 9/32 (28%) of the studies. The following negative emotions were reported in some athletes as a consequence of PFD: "embarrassment" in 6/9 of the studies (Nygaard *et al.* 1994; Eliasson *et al.* 2002; Da Roza *et al.* 2015; Hagovska *et al.* 2018; Skaug *et al.* 2022a, b); "fear" in 5/9 (Nygaard *et al.* 1994; Jácome *et al.* 2011; Gram & Bø 2020; Skaug *et al.* 2022a, b); "concern/anxiety/worry" in 5/9 (Nygaard *et al.* 1994; Jácome *et al.* 2011; Skaug *et al.* 2022a, b; Velázquez-Saornil *et al.* 2021); "annoyance" in 4/9 (Jácome *et al.* 2011; Skaug *et al.* 2022a, b; Velázquez-Saornil *et al.* 2021); and finally, "frustration" was reported by some athletes in 3/9 of the studies (Jácome *et al.* 2011; Skaug *et al.* 2022a, b).

Discussion

The primary aim of the present review was to investigate the experiences of symptoms of PFD in elite female athletes. There was heterogeneity in study designs, including a wide variety of athletic/sporting activity, and most of the information regarding the athletes' experiences came from quantitative research studies where the athletes' experience of PFD was not the main focus. This was predominantly quantitative research involving questionnaires. Only one mixed-methods study by Jácome *et al.* (2011) included a qualitative component to elicit athletes' experiences, and this involved a relatively small focus group ($n = 7$). It is notable that > 50% of the studies were published within the past 5 years, and this may indicate an increased interest in understanding the impact of PFD on athletes. Five main themes were identified, and only three studies contributed findings to all five themes. Two of these were recent studies by Skaug *et al.* (2022a, b), which, in addition to investigating prevalence, also investigated the impact and bother of PFD on powerlifters and weightlifters (Skaug *et al.* 2022a), and cheerleaders and gymnasts (Skaug *et al.* 2022b). The third study was the mixed-methods study by Jácome *et al.* (2011).

To date, systematic reviews of female athletes and PFD have predominantly focused on the prevalence of UI in this population (de Mattos Lourenco *et al.* 2018; Teixeira *et al.* 2018; Almousa & Bandin Van Loon 2019; Pires *et al.* 2020; Lourenco *et al.* 2021). Because prevalence was not the main focus of the present review, the incidence reported here was only that relating to those studies reporting elite athletes' *experiences* of PFD, and does not allow direct comparisons with previous reviews of the frequency of PFD in athletes.

The fact that UI was reported in all the studies in the present review was not surprising since UI is the most common form of PFD (Nygaard *et al.* 2008). Similar to reviews by de Mattos Lourenco *et al.* (2018) and Rebullido *et al.* (2021), the ICIQ-UI SF was found to be the most commonly utilized survey instrument. The prevalence and experiences of other forms of PFD, including POP, ARD, sexual dysfunction and pelvic pain, reported in the studies were also identified in the present review, and it is notable that, in all previous systematic reviews concerning athletes to date, only the incidence of UI was analysed. It is suggested that future systematic reviews should consider including the prevalence of other types of PFD to provide a more complete picture of PFD in these athletes. In a narrative review of physical activity and PFM function, Bø & Nygaard (2020) identified anal incontinence and POP as understudied research outcomes.

The present review included only studies involving "elite" athletes. In a systematic review that aimed to evaluate how sports psychology research has defined elite athletes, Swann *et al.* (2015) identified eight broad categories of an "elite or expert athlete". These included experience, international and/or national level, training, professionalism, involved in talent development, regional level, sport/country-specific measures, and university. Williams *et al.* (2017) suggested that, for team sports, the recommendation for defining "elite" is that success in highly competitive leagues and competitive experience should be given priority over international experience. In the present review, the authors used a definition of "elite" based on the recommendations of the above literature. However, it remains difficult to find a consistent definition of the term "elite" as it refers to athletes. In a systematic review investigating the prevalence of UI in nulliparous female athletes, Almousa & Bandin Van Loon (2019) highlighted that many studies failed to use level of sports (professional, amateur) to classify the participants.

The fact that "competition, training and physical activity" was most commonly reported as a trigger for symptoms of PFD followed by "specific movement during activity (sporting and daily life)" may not be surprising. Such activity may cause an increase in intra-abdominal pressure, impact the pelvic floor and is associated with SUI (Haylen *et al.* 2010), the most prevalent type of PFD reported in the present review. However, questions surrounding the effect of physical activity and exercise on the pelvic floor remain unresolved in the research literature, and a need for further high-quality research to fill the gaps in knowledge concerning the role of strenuous physical activity in symptoms of PFD has been identified (Bø & Nygaard 2020). It is also suggested that future research regarding triggers for symptoms of PFD, and when the symptoms occur in female athletes, should be conducted as this may help to inform the design of a pathway PFM rehabilitation programme for such athletes.

In seven of the studies, the PFD was reported as presenting in the second half/latter part of training or competition, and this may point to

PFM fatigue. Previous research has suggested that, while some uncertainty remains regarding the extent to which PFM fatigue affects UI, the development and/or worsening of UI may be influenced by PFM fatigue (Ree *et al.* 2007; Middlekauff *et al.* 2016; Thomaz *et al.* 2018).

In the present review, the studies that reported on strategies adopted by athletes to manage/mitigate symptoms of PFD indicated that, whilst many athletes reported wearing pads, pre-voiding and restricting fluids, few appeared to seek attention from a health professional. Similarly, de Mattos Lourenco *et al.* (2018) also reported strategies to prevent UI, including use of pads, pre-voiding and limiting fluid intake, and suggested that reasons why athletes do not discuss the condition or seek help may include the fact that they feel ashamed, or perceived that it is normal or inevitable at their age. Another possible reason may be that the athletes consider that their use of some strategies such as pre-voiding may be sufficient to manage their UI. Interview-based, qualitative research may assist in investigating this issue further.

Urinary incontinence is a treatable condition. Recent research has shown that PFMT in young continent women resulted in improved muscle activation and PFM strength (Pereira-Baldon *et al.* 2019). The findings of a Cochrane Review (Dumoulin *et al.* 2018) have shown that PFMT can cure or improve all types of UI, but is most effective in SUI. Similar to the findings of other reviews, the present authors suggest that it is important to provide educational resources for athletes regarding symptoms and treatment options for PFD, and educate the professionals (i.e. health professionals and coaches/trainers) involved with these athletes about the prevalence of PFD in athletes and increase screening for symptoms (de Mattos Lourenco *et al.* 2018; Teixeira *et al.* 2018; Almousa & Bandin Van Loon 2019; Pires *et al.* 2020).

In the present review, the findings regarding the impact of PFD on female athletes' QOL/daily life were quite varied, and consequently, no conclusion can be reached. Future research could include systematic reviews of UI and QOL in athletes, and conducting qualitative research may deepen knowledge and understanding of the impact and experiences of PFD on female athletes' QOL and daily life. Urinary incontinence has been shown to have a considerable impact on women's lives (Mendes *et al.* 2017), and have an adverse effect on QOL (Mallah *et al.* 2014; Amaral *et al.* 2015). A systematic review and meta-analysis on UI and QOL in both sexes reported that UI was associated with poor QOL, but an acknowledged limitation of this review was that only cross-sectional and case-control studies were included (Pizzol *et al.* 2021).

The fact that 11/12 studies of the impact of PFD on performance reported that it had an effect, and that some athletes had stopped or limited their activity during their sport, is of concern. A need for further research to investigate the mechanisms causing PFD in athletes has been identified (Gram & Bø 2020). It would also be interesting to evaluate if athletes who limit their sporting activity because of PFD have considered seeking or have sought treatment for their symptoms. Further mixed-methods or qualitative, interview-based research may assist in investigating this issue in athletes.

Only nine (28%) studies in the present review reported on the impact of PFD on the athletes' emotions, and only limited information was given in some. Embarrassment was the most frequently reported emotion, followed by fear, concern and anxiety. It is important that athletes are educated regarding PFD, and the treatment options available, to help allay, mitigate and resolve some of these negative emotions surrounding UI. Mendes *et al.* (2017) reported that UI is a condition that can involve embarrassment, stigma and distress in women. Once again, the present authors suggest that further qualitative, interview-based research may assist in investigating the impact of PFD on athletes' emotions.

Limitations

The limitations of the present review included the heterogeneity of the study designs, the inclusion of studies published in the English language only, and that the prevalence reported in this review only referred to the incidence of PFD in studies that described female athletes' experiences of PFD. However, the main limitation of the present review was the paucity of qualitative evidence that was available in the research literature concerning athletes' experiences of PFD.

Conclusion

The present review explored the experiences and impact of PFD in elite athletes, and found a relative paucity of qualitative evidence. Five main themes were identified. Further qualitative and mixed methods, sports-specific research may serve to deepen knowledge and understanding of

elite female athletes' experiences, and the impact of PFD on athletes' sporting activities and their daily lives, and enrich the understanding of this condition in women competing at an elite level.

Recommendations for qualitative research include further investigating:

- the impact of PFD on elite female athletes' emotions;
- why many elite female athletes do not discuss their PFD with others;
- triggers for PFD reported by elite female athletes;
- strategies adopted by elite female athletes to manage/mitigate their PFD;
- why many elite female athletes do not seek help from a health professional; and
- whether elite female athletes who limit their sporting activity because of PFD seek treatment.

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Each authors' contribution to the manuscript:

- E. Culleton-Quinn – review team member, study screening and manuscript writing;
- K. Bø – review team member and manuscript reviewing;
- N. Fleming – review team member, study screening and manuscript reviewing;
- D. Mockler – review team member and database searching;
- C. Cusack – review team member and manuscript reviewing; and
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Conflicts of interest

None.

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Appendix 1

Table 2. Summary of the characteristics of the included studies excluding information regarding experiences: (PFD) pelvic floor dysfunction; (BMI) body mass index; (SD) standard deviation; (ICIQ-UI SF) International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form; (ISI) Incontinence Severity Index; (FSFI) Female Sexual Function Index; (Rome III) Rome III Questionnaire; (ICIQ-VS) International Consultation on Incontinence Questionnaire – Vaginal Symptoms; (UI) urinary incontinence; (ARD) anorectal dysfunction; (AI) anal incontinence; (SD) sexual dysfunction; (POP) pelvic organ prolapse; (KAP) Knowledge, Attitude and Practice; (MUI) mixed urinary incontinence; (SUI) stress urinary incontinence; (UUI) urge urinary incontinence; (BFLUTS) Bristol Female Lower Urinary Tract Symptoms Questionnaire; (IQR) interquartile range; (KHQ) King's Health Questionnaire; (FISI) Fecal Incontinence Severity Index; (MSQ) Menstrual Symptom Questionnaire; (IIQ-7) Incontinence Impact Questionnaire; (UL) urinary leakage; (QUID) Questionnaire for Urinary Incontinence Diagnosis; (PFMs) pelvic floor muscles; (LEAF-Q) Low Energy Availability in Females Questionnaire; (IPAQ) International Physical Activity Questionnaire; (OAB-q) Overactive Bladder Questionnaire; (I-QOL) International Quality of Life Questionnaire; (ANOVA) analysis of variance; (POPQ) Pelvic Organ Prolapse Quantification; (UDI-6) Urinary Distress Inventory, Short Form; and (3IQ) Three Incontinence Questions Questionnaire

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Almeida *et al.* (2016), Brazil	To investigate occurrence of symptoms of PFD among young female nulliparous athletes and nonathletes, paired by BMI, and also influence of sport modality on occurrence and severity of urinary dysfunctions	Cross-sectional study	163 (67 athletes and 96 non-athletes, paired by BMI)	Volleyball, swimming, judo, artistic gymnastics, trampoline Nulliparous	Range = 15–29 Mean (± SD): athletes 18 (± 5) non-athletes 21 (± 4)	Questionnaire on background, sports practice and UI Included questions extracted from ICIQ-UI SF, ISI, FSFI, Rome III and ICIQ-VS	Descriptive statistics: Mann–Whitney *U* test chi-squared test Fischer's exact test odds ratio	UI (overall) (52.2%, 35/67) ARD: AI (flatus) (64.6%, 42/67) AI (faeces) (0%) constipation (68.2%, 45/67) SD: dyspareunia (13.8%, 4/29) vaginal laxity 13.8%, 4/29) POP (0% reported)
Cardoso *et al.* (2018), Brazil	To evaluate the prevalence of UI in female athletes practising high-impact sports, and its association with KAP	Observational and KAP survey	118	Athletics, handball, volleyball, basketball, futsal and judo Nulliparous	Mean (± SD) years = 21.6 (± 2.7) ≥ 18 and ≤ 30	Questionnaire on background, sports practice and UI (ICIQ-UI SF) KAP survey	Descriptive statistics: chi-squared test univariate and multivariate analysis odds ratio	UI (overall) (70.0%, 82/118) MUI (54%, 44/82) SUI (23%, 19/82) UUI (23%, 19/82) UI: during practice (61%, 50/82) during competition (45%, 37/82)
Carls (2007), USA	To identify the prevalence of SUI in young female athletes and assess the need for preventative UI education	Cross-sectional study	86 (34 school athletes and 52 college athletes)	Basketball, track, softball, volleyball, cheerleading, weightlifting and pompom dance Nulliparous	Range = 14–21 Average = 17	Questionnaire: BFLUTS revised to include questions pertaining to sports and educational needs	Descriptive statistics calculated by hand	UI: SUI (28%, 24/86) UUI (7%, 6/86)
Carvalhais *et al.* (2018), Portugal	To evaluate the prevalence of UI in female elite athletes competing in different sports compared to age-matched controls, and to investigate possible risk factors for UI	Cross-sectional study	744 (372 elite athletes and 372 age-matched controls)	Variety (*n* = 28), subdivided into technical, endurance, aesthetic, weight, ball games, power and gravity Nulliparous and parous	Range = 15–48 Median = 19 for both athletes and controls	Questionnaire: (section 1) background information (section 2) medical, obstetric and gynaecological, and UI history (section 3) sports practice and UI (ICIQ-UI SF)	Descriptive statistics: Mann–Whitney *U* test chi-squared test Fischer's exact test, binary logistic regression odds ratio	UI (overall) (29.6%, 110/372) SUI (19.6%, 73/372) UUI (3.8%, 14/372) MUI (5.9%, 22/372) Other UI (0.3%, 1/372) ARD: constipation (median = 33, IQR = 8.9)

Continued/

Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Carvalho *et al.* (2020), Brazil	To investigate the occurrence of urinary, anal, sexual and POP symptoms, as well as symptoms originating from premenstrual syndrome in women who practice cheerleading	Cross-sectional study	156 (78 cheerleaders and 76 non-athletes)	Athletes: high-performance cheerleaders, nulligravida, normal weight (BMI = 18.5–24.9 kg/m^2) Control group: non-athletic female university students Nulliparous	Range = 15–29 Mean (± SD): athletes 20.8 (± 2.3) non-athletes 21.9 (± 2.4)	Questionnaire on background information, sports practice and UI (ICIQ-UI SF) Included questions extracted from KHQ, FISI, FSFI, ICIQ-VS and MSQ	Descriptive statistics: Shapiro–Wilk test (to confirm normality of data) Mann–Whitney *U* test odds ratio	UI (overall) (26.9%, 21/78) UI (47.6%, 10/21) SUI (66.7%, 14/21) UUI (9.5%, 2/21) MUI (23.8%, 5/21) ARD: AI (62.8%, 49/78): flatus (55.1%, 43/78) constipation (25.6%, 20/78) SD: dyspareunia (53.8%, 40/71) vaginismus (2.8%, 2/71) dysmenorrhea (92.3%, 72/78) POP (7.7%, 6/78)
Caylet *et al.* (2006), France	To assess the prevalence of UI in elite athletes versus the general population, and to analyse the occurrence of urine loss	Survey: epidemiological athlete/non-athlete study	583 (157 elite athletes and 426 controls)	Athletes from volleyball, swimming, rugby, handball, basketball, football and "other" sports Controls from "physicians and occupational networks" Nulliparous and parous	Range = 18–35 Mean (± SD): athletes = 23.37 (± 4.5) non-athletes = 25.06 (± 4.6)	Questionnaire: a validated survey for use at a hospital clinic – medical, obstetric and gynaecological history, and physical activities, including type of sports, and duration of activities and UI	Descriptive statistics: Student's *t*-test Kruskal–Wallis test chi-squared test Fischer's exact test McNemar's test	UI (overall) (28%, 44/157) SUI (41.9%, 18/44) UUI (34.9%, 15/44) MUI (23.2%, 10/44)
Da Roza *et al.* (2015), Portugal	To investigate hypothetical associations between level of athletic performance and volume of training in young nulliparous female trampolinists with urine leakage	Cross-sectional cohort study	22	Trampolinists, classified as elite and non-athlete Nulliparous	Range = 14–25 Mean (± SD) = 18.1 (± 2.4)	Questionnaire: background, sports practice and UI (ICIQ-UI SF)	Descriptive statistics: Shapiro–Wilk test Kruskal–Wallis *H* test Spearman's rank correlation coefficient	UI (72.7%, 16/22) ARD (constipation) (0%)
Dobrowolski *et al.* (2020), Canada	To determine the prevalence, impact and management of SUI among rope-skipping athletes First survey identified the prevalence, impact and management strategies of SUI among current athletes Second survey identified whether SUI contributes to athletes' decisions to retire from participation	Cross-sectional observational study	Survey 1 (current athletes) = 103 (89 females and 14 males) Survey 2 (retired athletes) = 77 (74 females and 3 males)	Rope-skipping athletes, current and retired Nulliparous and parous	Female range = 13–59 Median (IQR) = 16 (15–21) Male range = 13–35 Median age (IQR) = 18 (13–28)	Questionnaire: (survey 1) background information, 11-point Likert scale regarding how UI interfered with rope skipping, ICIQ-UI SF and an unvalidated sport-specific questionnaire inspired by the IIQ-7 (survey 2) questionnaire asking reasons for retiring	Descriptive statistics: odds ratio	Prevalence in female athletes: UI (SUI) (75%, 67/89) ARD (constipation) (12%, 10/87)

Continued/

Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Dockter *et al.* (2007), USA	To determine the prevalence of UI in female collegiate athletes compared to age-matched controls, and if there was a difference in the prevalence of UI among various sporting activities; also examined strategies to prevent or manage UI in this population	Prospective cross-sectional survey	177 (109 female collegiate athletes and 68 non-athletic controls)	Athletes competing in track and field athletics, basketball, soccer, softball, volleyball, and cheerleading Nulliparous and parous	Range = 18–25 Mean (± SD): athletes = 19.17 (± 1.04) non-athletes = 18.82 (± 0.75)	Questionnaire designed for the purpose of the study	Descriptive statistics: independent *t*-test chi-squared test	SUI: UL during coughing, sneezing and/or laughing (46.8%, 51/109) UL during physical activity (40.4%, 44/109) UUI (29.6%, 32/109)
Eliasson *et al.* (2002), Sweden	To survey the prevalence of SUI in female elite trampolinists	Cross-sectional study	35	Trampolinists Nulliparous	Range = 12–22 Mean = 15	Questionnaire designed for the purpose of the study Pad test PFM strength measured by perineometer	Descriptive statistics: Mann–Whitney *U* test Spearman's rank correlation coefficient	SUI (overall) (80%, 28/35), but only during trampoline training
Eliasson *et al.* (2008), Sweden	To describe the occurrence of urinary leakage in young and mostly nulliparous women with a history of regular organized trampoline training as adolescents, and to identify possible risk factors	Cross-sectional study	305 (85 in competition group and 220 in recreational group)	Female ex-trampolinists in Sweden who held a licence for trampolining between 1995 and 1999 Nulliparous and parous	Range = 18–44 Median = 21	Questionnaire designed and validated for the study of UI in young nulliparous/ primiparous women	Descriptive statistics: Mann–Whitney *U* test chi-squared test logistic regression	UI (overall) (68%, 209/305) SUI (45%, 138/305) Current UI: competition group (57%, 48/85) recreational group (48%, 106/120) ARD (constipation): overall (14.1%, 43/305) competition group (13%, 11/85) recreational group (15%, 32/120)

Continued/

Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Faulks & Catto (2021), Australia	To establish the prevalence of SUI among elite female rugby union players within Australia; study further analysed rates of SUI between participants playing in the forward and back positions, self-reported consequences of SUI on athletic performance during a game or training session, and the percentage who believed SUI to be a reason for withdrawing from rugby union in the future	Cross-sectional study	65	Elite female rugby union players from the Australian Rugby Union Nulliparous and parous	Mean (± SD) = 26 (± 5.1)	Questionnaire: modified version of the QUID	Descriptive statistics: chi-squared test	SUI (60%, 39/65) during a game or training
Ferreira *et al.* (2014), Portugal	To verify the effectiveness of the PFM rehabilitation programme in female volleyball athletes, analysing the amount and frequency of UL	Experimental	32 (16 in experimental group and 16 in control group)	Volleyball athletes with symptoms of SUI Nulliparous	Mean ± SD (range): experimental group = 19.4 ± 3.24 (16–25) control group = 19.1 ± 2.11 (17–26)	Questionnaire: baseline information pad test urinary diary assessment of frequency of UI	Descriptive statistics: Shapiro–Wilk test Student's *t*-test chi-squared test Fischer's exact test	All participants in the study reported symptoms of SUI
Gram & Bø (2020), Norway	To investigate the prevalence of and risk factors for UI in rhythmic gymnasts, the impact of UI on their performance, and their knowledge of the pelvic floor and PFMT	Cross-sectional study	107	Rhythmic gymnasts Nulliparous	Range = 12–21 Mean (± SD) = 14.5 (± 1.6)	Questionnaire: background, influence of UI on sports practice and ICIQ-UI SF Triad-specific self-report questionnaire LEAF-Q Clinical hypermobility testing	Descriptive statistics: Kolmogorov–Smirnov test Shapiro–Wilk test Student's *t*-test chi-squared test Fischer's exact test logistical regression	UI was reported in 31.8% (34/107) athletes, of which: SUI (61.8%, 21/34), of which 57.1% reported leakage only during physical activity UUI (8.8%, 3/34) MUI (17.6%, 6/34) no obvious reason (11.8%, 4/34)

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Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Hagovska *et al.* (2018), Slovakia	To determine the prevalence of SUI symptoms in sportswomen (high-intensity physical activity) and non-sportswomen (low-intensity physical activity), according to estimated intensity of physical activity in metabolic equivalents using the IPAQ questionnaire; another goal was to identify relationships between SUI symptoms, intensity of physical activity and QOL	Cross-sectional study	557 (270 sportswomen and 287 non-sportswomen)	Women from university sport clubs at national levels (no further detail regarding types of sport) Nulliparous	Mean (± SD): all = 20.9 (± 2.8) sportswomen = 20.7 (± 3.3) non-sportswomen = 21.1 (± 2.3)	Questionnaires: ICIQ-UI SF OAB-q I-QOL IPAQ	Descriptive statistics: logistic regression odds ratio Pearson's correlation coefficient	UI (slight UL) (6.14%, 33/270)
Jácome *et al.* (2011), Portugal	To investigate the prevalence of UI in a group of female athletes, and to explore the impact on their lives by identifying their emotions regarding urine loss and techniques used to reduce episodes of UI	Cross-sectional survey and focus group	106	Track and field, basketball, and indoor football Nulliparous and parous	Mean (± SD) = 23(± 4.4) Range not given Inclusion criteria ≥ 18 and < 45	Questionnaire ($n = 106$): background, sports practice, UL characterization and risk factors for UI Focus group ($n = 7$): non-directive manner and semi-structured guide	Descriptive statistics: binomial test chi-squared test Fischer's exact test two-way ANOVA thematic analysis	UI (overall) (41.5%, 44/106) SUI (61.4%, 27/44) UUI (20.5%, 9/44) MUI (18.2%, 8/44)
Larsen & Yavorek (2006), USA	To evaluate both baseline pelvic support and incontinence in relation to physical activity in nulliparous college age women	Prospective observational study	144	Women at the US Military Academy College (athletes) Nulliparous	Mean = 19.6	Questionnaire designed for the purpose of the study POPQ	Descriptive statistics	UI (overall) (19.4%, 28/144) SUI (43%, 12/28) UUI (28.5%, 8/28) MUI (28.5%, 8/28) POP (overall) (50%, 72/144) stage I pelvic support (46%, 66/144) stage II (4%, 6/144)

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Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Lúðvíksdóttír *et al.* (2018), Iceland	To measure and compare PFM strength in competition-level athletes and untrained women, evaluate the women's ability to contract their PFMs correctly, explore the frequency of SUI, and assess the women's knowledge and awareness of the PFMs	Case control study	34 (18 athletes and 16 untrained women)	Various sports (handball, soccer, gymnastics, badminton, weightlifting, bootcamp and CrossFit) Nulliparous	Range = 18–30 Mean (± SD): athletes = 24.2 (± 3.2) untrained = 24.1 (± 2.9)	Questionnaire: background, exercise training and knowledge of PFMs (ICIQ-UI SF) PFM strength measurement	Descriptive statistics: Student's *t*-test odds ratio binary logistical regression	UI (61.1%, 11/18) – reported as occurring during high-intensity exercise and, therefore, assumed to be SUI
Nygaard *et al.* (1994), USA	To determine the prevalence of the symptoms of UI during athletic endeavours among a group of female elite college varsity athletes	Cross-sectional study	144	Gymnastics, volleyball, swimming, field hockey, softball, basketball, golf, track athletics and tennis Nulliparous	Mean (± SD) = 19.9 (± 3.3)	Questionnaire designed for the purpose of the study	Descriptive statistics: Student's *t*-test chi-squared test Fisher's exact test	UI (49%, 71/144) – 28% (40/144) admitted to at least one episode of UI while practising or competing in their sport Other bladder symptoms noted during competition included: urgency (31%, 45/144) increased frequency (37%, 53/144) bladder pain (7%, 10/144)
Nygaard (1997), USA	To determine whether women engaged in strenuous, provocative exercise are more likely to be incontinent in future life than similarly fit women who participated in less-provocative exercise	Retrospective cohort study	104	Ex-Olympian, low-impact (swimming) and high-impact (gymnastics, and track and field athletics) sports Nulliparous and parous	Mean (range): low-impact group = 42.4 (30–54) high-impact = 46.2 (30–63)	Questionnaire designed for the purpose of the study	Descriptive statistics: two-tailed *t*-test chi-squared test Fisher's exact, Wilcoxon signed-rank test logistic regression	UI (during Olympic sporting activity): high-impact athletes (35.8%, 19/53) low-impact athletes (4.5%, 2/44) SUI (current): high-impact athletes (41.1%, 23/56) low-impact athletes (50%, 24/48) UUI (current): high-impact athletes (33.9%, 19/56) low-impact athletes (16.7%, 8/48)
Pires *et al.* (2020), Portugal	To investigate the effects of PFM training in elite female volleyball athletes, and whether it is an effective therapy for SUI	Randomized controlled trial	13 athletes (7 in experimental group and 6 in control group)	Volleyball athletes Nulliparous	Mean ± SD (range): experimental group = 22.7 1± 4.99 (18–30) control group = 21.83 ± 5.19 (18–31)	Questionnaire: background sociodemographic and anthropometric data (KHQ) Pad test PFM strength measurement by perineometer	Descriptive statistics: Shapiro–Wilk test Levene's test Box's *M* test Student's *t*-test ANOVA	UI (61.5%, 8/13)

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Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Poświata *et al.* (2014), Poland	To determine the prevalence of SUI in a group of elite female endurance athletes, and compare the SUI rates in the groups of female cross-country skiers and runners to determine whether weather conditions during training (e.g. temperature and humidity) might also influence the prevalence of UI	Cross-sectional study	112 female endurance athletes (57 cross-country skiers and 55 runners)	Cross-country skiers and runners Nulliparous	Mean (± SD): cross-country skiers = 26.61 (± 4.41) runners = 29.49 (± 6.02).	Questionnaire: short form of the UDI-6	Descriptive statistics: chi-squared test	UI (50%, 56/112) SUI (45.54%, 51/112) UUI (27.68%, 31/112) MUI (18.75%, 21/112) Frequency (58.04%, 65/112) Bladder-emptying problems (33.04%, 37/112) Pelvic pain, or discomfort in the lower abdominal or genital area (36.61%, 41/112) Overall, no statistically significant differences were noted between the groups
Rodríguez-López (2021), Spain	To determine the prevalence of UI among elite athletes, and to compare prevalence between sexes and across different sports modalities	Observational, cross-sectional study	754 elite athletes (455 females and males 299)	Wide variety (38 sports, e.g. athletics, soccer, gymnastics, rugby, judo, swimming, hockey, karate and orienteering dance) Nulliparous and parous	Mean (± SD): overall = 23.04 ± 7.16 females = 23.18 ±7.10 males = 22.81 ± 7.26	Questionnaire: background, anthropometric data, medical history, sports practice and UI data ICIQ-UI SF 3IQ ISI	Descriptive statistics: Shapiro–Wilks test Student's *t*-test chi-squared test odds ratio Pearson's correlation coefficient	UI (females) (45.1%, 205/455) SUI (66%, 135/205) UUI (16%, 33/205) MUI (4%, 8/205) ARD (constipation) (13.2%, 60/455)

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Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Sandwith & Robert (2021), Canada	To determine the prevalence of UI among female university varsity rugby players, and understand when it occurred and assess the degree of bother experienced	Cross-sectional study	95	Female rugby players Nulliparous	Mean age (± SD) years = 19.9 ± 1.8	Questionnaire: background information, i.e. age, height, weight and hours spent training A specific, rugby-related activity questionnaire was developed: degree of bother, previous treatment, desire for treatment, when incontinence occurred and coping strategy UDI-6	Descriptive statistics: unpaired *t*-test linear regression	UI (54%51/95) SUI (82%, 42/51) UUI (39%, 20/51) Bladder-emptying problems (16%, 8/51) Pelvic pain, or discomfort in lower abdominal or genital area (26%, 13/51)
Skaug *et al.* (2022a), Norway	To investigate prevalence of and risk factors for PFD in powerlifters and Olympic weightlifters, the impact of and bother caused by PFD, and knowledge of the PFMs	Cross-sectional study	384 (180 females and 204 males)	Top national- and international-level male and female powerlifters, and Olympic weightlifters Nulliparous and parous	Mean (range): female lifters = 31.0 female weightlifters = 10.7 (18–65) male lifters = 34.0 male weightlifters = 13.5 (18–84)	Questionnaire: background information on age, BMI, parity, training frequency, level of competition, years specializing in sport, generalized hypermobility, straining at toilet, female athlete triad and knowledge of PFMs ICIQ-UI SF Questions from: ICIQ-B for AI ICIQ-V for POP LEAF-Q	Descriptive statistics: Shapiro–Wilks test odds ratio logistic regression	Female lifters: UI (50%, 90/180) SUI (41.7%, 75/180) UUI (1.7%, 3/180) MUI (3.9%, 7/180) ARD (female athletes): AI (80%, 144/180) liquid (32.8%, 59/180) solid (7.2%, 13/180) gas (76.7%, 138/180) Straining to defecate (female athletes): never (9.4%, 17/180) rarely (39.4%, 71/180) some of the time (46.7%, 84/180) most of the time (3.9%, 7/180) always (0.6%, 1/180) POP (23.3%, 42/180)

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Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Skaug *et al.* (2022b), Norway	To investigate the prevalence of and risk factors for UI and AI in high-performance female artistic gymnasts, team gymnasts and cheerleaders, and the bother of UI and AI, the influence of SUI on sport performance, and the athletes' knowledge of the PFMs	Cross-sectional study	319 (68 artistic gymnasts, 116 team gymnasts and 135 cheerleaders)	Artistic gymnasts, team gymnasts and cheerleaders at the top national junior and senior levels in Norway Parity not assessed because of young age	Mean ± SD (range): all athletes = 17.4 ± 3.2 (12–36) artistic gymnasts = 16.8 (3.6, 12–36) team gymnasts = 17.1 ± 2.7 (13–28) cheerleaders 17.9 ± 3.3 (12–29)	Questionnaire: background, medical and sport practice, and knowledge of the PFMs ICIQ-UI SF Questions from: ICIQ-B for AI LEAF-Q	Descriptive statistics: logistic regression odds ratio chi-squared test	UI (overall) (67.4%, 215/319): SUI (63%, 201/319) UUI (11.6%, 31/319) MUI (9.4%, 7/215) UI (artistic gymnasts) (48/68, 70.6%): SUI (70.6%, 48/68) UUI (8.8%, 6/68) MUI (8.8%, 6/68) UI (team gymnasts) (83.6%, 97/116): SUI (80.2%, 93/116) UUI (12.9%, 15/116) MUI (11.2%, 13/116) UI (cheerleaders) (51.9%, 70/135): SUI (44.4%, 60/135) UUI (11.9%, 16/135) MUI (8.1%, 11/135) Straining to void (all athletes): never (36.1%, 115/319) occasionally (45.5%, 145/319) frequently (14.1%, 45/319) daily (4.4%, 14/319) ARD (overall AI) (84%, 268/319): liquid (40.8%, 130/319) solid (12.2%, 39/319 gas (81.2%, 259/319) AI (artistic gymnasts) (82.4%, 56/68): liquid (36.8%, 25/68) solid (11.8%, 8/68) gas (82.4%, 56/68) AI (team gymnasts) (86.2%, 110/116): liquid (41.4%, 48/116) solid (13.8%, 16/116) gas (83.6%, 97/116) AI (cheerleaders) (83%, 112/135): liquid (42.2%, 57/136) solid (11.1%, 15/135) gas (78.5%, 106/135) Straining to defecate (all athletes): never (3.1%, 10/319) rarely (34.5%, 110/319) some of the time (52.4%, 167/319) most of the time (9.7%, 31/319) always (0.3%, 1/319)

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Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Thyssen *et al.* (2002), Denmark	To determine the frequency of urinary loss in elite women athletes and dancers	Cross-sectional study	291	Badminton, handball, basketball, volleyball, athletics, gymnastics, aerobics and ballet Nulliparous and parous	Mean (range) = 22.8 (14–51)	Questionnaire designed for the purpose of the study	Descriptive statistics: McNemar's test	UI: while participating in sport or in daily life (51.9%, 151/291) while participating in sport (43%, 125/291)
Velázquez-Saornil *et al.* (2021), Spain	To assess the prevalence of UI in female athletes, and the methods of containment, the characteristics of leakage and the risk factors that may lead to UI; the biopsychosocial component of UI in this group of athletes was also analysed	Cross-sectional study	63	Athletics: long-distance running, speed events, middle-distance races, jumping events and throwing events Nulliparous and parous	Mean ± SD (range) = 30.78 ± 12.16 (18–61)	Questionnaire: KHQ ICQ-UI SF	Descriptive statistics: chi-squared test Student's *t*-test	UI (44.4%, 28/63) SUI (89.3%, 25/28) (25% reported coughing and sneezing, and 64.3% reported coughing and sneezing during physical exercise)
Wikander *et al.* (2019), Australia	To determine the prevalence of UI in competitive women powerlifters and establish if commonly cited risk factors affect its incidence	Cross-sectional study	134	Competitive powerlifters Information regarding parity not collected	Range = 20–59	Questionnaire: background and sports-specific questions ISI	Descriptive statistics: Kruskal–Wallis test ANOVA Cohen's f^2 Kendall's tau-b correlation coefficient thematic analysis of comments section	UI: at some stage in life (41%, 55/134) during lifting activities (37%, 50/134) during everyday activities (11%, 15/134)
Wikander *et al.* (2020), Australia, UK, USA, Canada and New Zealand	To determine the prevalence of UI and athletic incontinence, and establish which activities and contexts were most likely to provoke UL in female CrossFit competitors	Cross-sectional study	452	Female CrossFit competitors Nulliparous and parous	Mean ± SD (range) = 36 ± 9 (20–63)	Questionnaire developed specifically for CrossFit participants with a focus on the context in which UI occurred and the exercises most likely to cause it ISI	Descriptive statistics	UI: experienced at some point in their life (46%, 208/452) experienced in the 3 months prior to the study (41.8%, 189/452)

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Table 2. (*Continued*)

Study, country	Aim	Study design	Sample size (*n*)	Type of sport/ participants	Age of participants (years)	Data collection	Analysis	Prevalence of PFD symptoms in athletes
Wikander *et al.* (2021), Australia, UK, USA, Canada and New Zealand	To determine the prevalence of UI in competitive women powerlifters, identify possible risk factors and activities likely to provoke UI, and establish self-care practices	Cross-sectional study	480	Women powerlifters Nulliparous and parous	Mean ± SD (range) = 35 ± 10 (20–89)	Questionnaire: background information, and questions to identify actions and events associated with UI and self-care strategies ISI	Descriptive statistics: Kendall's tau-b correlation coefficient eta correlation coefficient	UI: experienced at some point in their life (48.8%, 234/480) experienced in the 3 months prior to the study (43.9%, 211/480)
Wikander *et al.* (2022), Australia and other English-speaking countries (not specified)	To explore the multifactorial issue of UI in competitive female weightlifters with a focus on prevalence, risk factors and activities provoking UI, identify self-care strategies used by incontinent competitive women weightlifters, and finally, assess confidence in performing PFMT and utilization of women's health professionals	Cross-sectional study	191	Women weightlifters Nulliparous and parous	Mean ± SD (range) = 35.92 ± 12 (20–89)	Questionnaire: background, and questions to identify actions and events associated with UI and self-care strategies ISI	Descriptive statistics: Pearson's correlation coefficient	UI: experienced at some point in their life (36.6%, 70/191) experienced in the 3 months prior to the study (31.9%, 61/191)