Pelvic Floor Muscle Training In Women Practicing High-impact Sports: A Systematic Review

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ABSTRACT

Urinary incontinence (UI) in female athletes can impair their quality-of-life (QoL) and reduce their participation in sports. This review aims to evaluate the effect of pelvic floor muscle training (PFMT) in treating UI in women participating in high-impact sports. Furthermore, to assess the influence of PFMT on pelvic floor muscles (PFM) function and the UI impact on their QoL. For this purpose, a systematic review of randomized controlled trials (RCTs) and non-RCTs was performed. An electronic search was conducted on PubMed, EMBASE, SciELO, and Scopus. The quality of evidence was assessed using the PEDro and ROBINS-I scales. The Consensus on Exercise Reporting Template (CERT) was used to assess the quality of PFMT protocols. All studies were available in full-text including incontinent female participants who are practitioners of high-impact sports, investigating PFMT vs control groups(inactive) or undergoing other treatments. Three RCTs and two non-RCTs (104 participants) were analyzed. PFMT provided a significant improvement in UI symptoms with a reduction in the frequency (n = 3) and the amount of UI (n = 5). PFM function was assessed in three studies, and two found improvement in maximal contraction and one in vaginal resting pressure in favor of PFMT. None of the two studies that assessed QoL found a difference after PFMT intervention.

Introduction

According to the International Continence Society (ICS) and the International Urogynecological Association (IUGA), urinary incontinence (UI) is defined as the involuntary loss of urine [1]. The most prevalent type of UI among young and physically active women is the stress UI (SUI), which occurs during increases in intra-abdominal pressure (IAP) [2]. High-impact sports, such as those involving jumping and/or running, have as characteristics the repetitive impacts on the pelvic floor generated by ground reaction forces and/or increases in IAP [3, 4]. Due to these characteristics, studies show that those women who practice high-impact sports have 2.77 times more likely to present complaints of UI when compared to sedentary women in the same age group [3]. Besides, their UI rates are greater when compared to women who practice low-impact sports (58.10 and 12.48 %, respectively) [5].

Recent studies have shown that UI symptoms are most prevalent in young and high-impact sports practitioners [6], ranging from 25.9 to 70 % [7, 8], and SUI symptoms rates range from 69 to 72.7 % [9, 10]. Regarding SUI prevalence by sport, the most prevalent high-impact sports are volleyball and trampoline [6, 8, 11], as well as running activities [11]. Incontinent athletes can also present impairments in their quality-of-life (QoL), such as restrictions on

sports and/or social activities [12], and even leading to the abandonment of exercise [4].

Currently there are two opposing hypotheses that explain how strenuous exercise can affect PFM [13], the first believes that an increased IAP during the exercise can lead to a PFM strengthening due to a co-contraction of these muscles. The opposite hypothesis explains that exercise can overload, stretch, and weaken PFM due to constant increases in IAP. Thus, according to the second hypothesis, strenuous exercise can lead to a reduction in the maximum voluntary contraction (MVC) [14], which means loss of a muscle's ability to generate force [15], and in support of pelvic organs [16]. Moreover, PFM fatigue can influence the development and/or worsening of SUI symptoms; however, studies addressing fatigue are scarce and conclusions are limited [17].

The PFM training (PFMT) is considered the first-line treatment for SUI in the general population [18]. Compared with no treatment or inactive control treatments, women with SUI are eight times more likely to report a cure with PFMT at the end of treatment [19]. In addition, the PFMT promotes significant improvement in QoL, influencing the physical, mental and social aspects of these women [19, 20]. Currently, we have validated questionnaires available to assess QoL in women with UI, published with strong scientific evidence [21]. Few clinical trials demonstrate the effect of PFMT on UI symptoms in women who practice high-impact sports, as well as on the QoL and PFM function in these women.

Therefore, this study aims to systematize the scientific evidence that assesses the effect of PFMT on UI symptoms in women who practice high-impact sports. The secondary objective was to assess the influence of PFMT on PFM function and the impact of UI on women's QoL.

Materials and Methods

This systematic review was registered in PROSPERO and has followed the Preferred Reporting Items for Systematic Reviews (PRISMA) guidelines. The PICOT strategy was used to define the participants (P), intervention (I), comparison (C), outcomes (O) and types of studies (T), and to assist in the construction of the following research question: what is the effect of PFMT on UI symptoms in women who practice high-impact sports? The inclusion criteria were: trials women who practice high-impact sports (sports involving running and/or jumping) [4], the interventions including PFMT, and studies with a primary or secondary aim to assess UI symptoms. The articles should compare their results with control groups (inactive) or with other interventions. These studies should be available in English, Portuguese or Spanish and in full text. Pregnant women and/or with comorbidities such as obesity, heart disease, orthopedic, rheumatologic, immunological, respiratory and/or neurological conditions were excluded. Also, all the studies included in this systematic review, excluded women unable to correctly contract the PFM or women with pelvic organ prolapse symptoms.

All studies cited within EMBASE, PubMed, SciELO and Scopus databases from inception to November 2020 were included. The search strategies used in each database are described in ▶ **Table 1**.

The primary outcome of this review was the UI symptoms (amount and frequency of urinary losses), while secondary outcomes were the PFM function and the impact of UI on women's QoL. Two independent researchers (FSF and ERMA) performed the selection according to the eligibility criteria. After the duplicate removal, two reviewers independently screened titles and abstracts of identified articles under the initial search strategy. Potentially relevant trials were then retrieved for independent full-text evaluation. A second search was performed by manually selecting the bibliographic references of articles already included in the review. The same two researchers performed data extraction using a standardized table format containing the following information: author, year of publication and country; number of participants; the primary objective; the outcome measures to assess the UI symptoms, the PFM function, and the impact of UI on women's QoL; the interventions used in the study; and the main results regarding the primary and secondary outcomes.

The risk of bias of randomized controlled trials (RCTs) was assessed by two researchers (FSF e ERMA) using the Physiotherapy Evidence Database (PEDro) scale [22]. In cases of disagreement, a third researcher (TR) made the final decision in a consensus meeting. The PEDro scale proved to be a valid measure of the methodological quality of clinical trials [23] The total score ranges from 0 to 10. Studies with scores less than 4 are considered "poor", 4 to 5 are considered 'fair', 6 to 8 are considered 'good' and 9 and 10 are considered 'excellent' [24].

The Risk of Bias in Non-Randomized Studies – of Interventions (ROBINS-I) tool was used for non-RCTs [25] and the same researchers performed the analysis. This tool assesses the risk of bias in estimates of the efficacy or safety (benefit or harm). It consists of seven domains, where the first two (confounding and selection of participants for the study) address pre-intervention issues, the third domain (classification of interventions) deals with the issues of the intervention itself and the last four domains (deviations from the intended interventions, missing data, measurement of the outcome, and selection of the reported result) address post-interven-

▶ **Table 1** Database search strategies.

Database	Search strategies
PubMed (https://pubmed.ncbi.nlm.nih.gov/)	*(women OR athletes OR "female athlete" OR "sports women")* ***AND*** ("high-impact" OR sports OR exercise OR "physical activity") ***AND*** ("pelvic floor" OR "pelvic floor muscle training" OR physiotherapy) ***AND*** *("urinary incontinence" OR "stress urinary incontinence" OR "urge urinary incontinence" OR "pelvic floor disorders" OR "athletic incontinence").*
Embase (https://www.embase.com)	
SciELO (https://search.scielo.org/)	
Scopus (https://www.scopus.com/search/form.uri?display=basic)	(*sportwomen OR athletes OR female AND athlete*) ***AND*** (*"high-impact" OR sports OR exercise*) ***AND*** (*"urinary incontinence" OR "stress urinary incontinence" OR "urge urinary incontinence" OR "pelvic floor disorders"*).

tion issues. At the end, each domain can be classified into: "Low Risk", "Moderate Risk", "Serious Risk" and "Critical Risk" of bias.

For the assessment of the PFMT protocols, the Consensus on Exercise Reporting Template (CERT) was used [26]. The CERT provides guidance on a minimum set of key items considered essential for reporting replicable exercise programs. It consists of a total of 19 items and sub-items, listed in seven domains: what – materials; who – provider; how – delivery; where – location; when how much – dosage; what, how – tailoring; and how well - compliance/planned or actual. For the score, one point is added to each item described in the study. The two researchers applied the CERT, and the discrepancies were resolved through discussion between the authors.

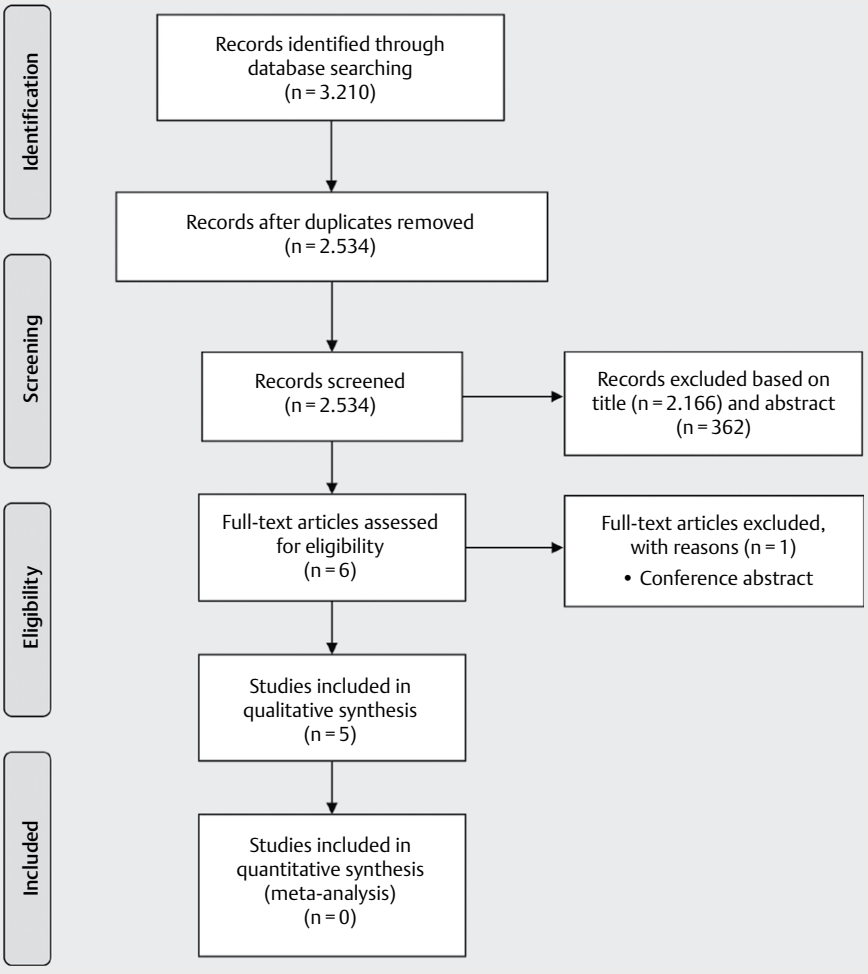
Results

A search of the selected databases returned 3,210 articles for screening, among which 676 were removed as duplicates, 2,166 articles were excluded based on title, and 362 based on abstract. Six articles were reviewed for eligibility, and one was excluded, with reason listed in ▶ **Fig. 1**

▶ **Table 2** shows the study characteristics, primary aim, outcome measures and interventions of the five studies included. The PEDro Scale score was also included [27–29]. All articles included women with at least one UI symptom. A total of 104 participants were included, with ages ranging from 16 to 46 years, and only two studies did not present the age range [30, 31]. The most prevalent sport was volleyball with 46 women participants [27, 28]. The studies were published between 1997 and 2020.

The UI symptoms were assessed using three different methods: International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) [30], the Pad test [27, 28, 31], and a seven-day voiding diary [27]. Sherman, Davis and Wong [29] evaluated the UI symptoms through questions elaborated by the authors. Regarding the Pad test, the authors used the 2-hour Pad test [28], or during the first 15 minutes of sports practice [27]. The study by Sousa et al. [31] did not specify the duration of the Pad test.

The PFMT was compared with other interventions in four of the five studies. The PFMT was compared to educational activities [27, 29], to the PFMT associated with biofeedback [29], to an



▶ **Fig. 1** PRISMA Flowchart (PRISMA = Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [43].

▶ **Table 2** Study characteristics, primary aim, outcome measures and interventions of the five studies included in the review, and the risk of bias (PEDro Scale) of the three randomized clinical trials.

Author, year (country)	Sample size/age/sports played	Primary aim	Outcome measures for UI symptoms	Intervention	PEDro score
DA ROZA et al., 2012 (Portugal)	7 female athletes/20.0 ± 0.8/ Gymnastics, trampoline, figure skating, synchronized swimming and handball.	To evaluate the effect of a comprehensive PFMT program on UI symptoms in nulliparous and sportsmen youth.	ICIQ-UI SF	**Intervention:** PFMT + DVD with educational material	–
				PFMT protocol: It consisted of four steps conducted for 2 weeks each (8 weeks): (1) PFM awareness, (2) PFM contraction in different positions with progressive weights, (3) PFM attempts during exercise activities. running and walking and (4) attempts to contract PFM during sports activities. The meetings with the participants were held every 15 days, where the physiotherapist showed the new exercises for the next step and instructed them to perform them every day until fatigue. An explanatory DVD illustrating the exercise program has been provided for use at home. All participants were instructed to write an exercise diary, reporting their progress and adherence to the project.	
FERREIRA et al., 2014 (Portugal)	32 female athletes: experimental group (EG) = 16 and control group (CG) = 16/EG: 19.4 ± 3.24 and CG: 19.1 ± 2.11/Clube Atlético de Voleibol.	Verify the effectiveness of a PFMT program in federated nulliparous athletes.	**Pad test:** amount of urinary losses in the first 15 minutes of volleyball practice.	**Intervention:** PFMT + educational action vs control group that only had access to the leaflet with a summary of the educational action.	5/10
			Voiding diary: daily frequency of UI episodes for 7 consecutive days.	**PFMT protocol:** Exercises were performed at home, included 30 slow contractions and 4 fast contractions after each slow contraction, in different positions and daily for 3 months. Weekly visits were made to the club during the study period to ensure motivation and adherence to PFMT both at home and after training.	
PIRES et al., 2020 (Portugal)	14 elite athletes were randomized, 13 were analyzed: experimental group (EG) = 7 and control group (CG) = 6/EG: 22.71 ± 4.99 and CG: 21.83 ± 5.19/Federação Portuguesa de Voleibol.	To investigate the effects of PFMT in elite volleyball athletes and whether it is an effective therapy for SUI.	2-hour pad test	**Intervention:** PFMT + educational action and app illustrating the exercise program to use at home vs control group (inactive).	7/10
				PFMT protocol: consisted of 3 phases that lasted 16 weeks: awareness/stabilization, strength and strength training. The first phases were carried out at home and for 2 weeks. The 1st phase started in the lying position and gradually evolved to the standing position, 10 slow contractions of 10 seconds were performed with the same relaxation time. In the 2nd phase, the contraction time was greater than the relaxation time, progressively increasing the degree of difficulty over time.	
				The 3rd phase was carried out at the athlete's training site and for 12 weeks (divided into 2 parts, the 1st with 4 and the 2nd with 8 weeks) in general (1st part) and specific (2nd part) exercises. In the 2nd part, fast and strong contractions (1–2 seconds) were performed before and during any increase in intra-abdominal pressure, however, the number of sets depended on what was requested by the trainer	
SHERMAN; DAVIS; WONG, 1997 (United States)	44 women were randomized, 39 were analyzed/28,5 ± 7,2/ Active duty soldiers.	Determine whether PFMT exercise (Kegel) can help female soldiers overcome exercise-induced incontinence with minimal therapeutic intervention.	Number and amount of urinary loss, degree of urinary urgency and enuresis episodes.	**Intervention:** PFMT + biofeedback, educational action, bladder training and voiding urgency control (group 1) vs PFMT + educational action, bladder training, voiding urgency control and biofeedback as a stopwatch only (group 2).	5/10
				PFMT protocol: During supervised practice, group 1 performed 5 contractions of 10 seconds with 10 seconds of relaxation and an interval of 30 seconds between each attempt for 2 months for both groups. The study did not make it clear how the PFMT protocol for group 2 was performed.	
				For home practice, patients in both groups were instructed to practice 10-second contractions with 10-second relaxation, for 20 min, twice a day.	
SOUSA et al., 2015 (Portugal)	7 nulliparous young athletes: supervised group = 4 and unsupervised group = 3/21,7 ± 3,6/Athletics and football.	To evaluate the effect of a comprehensive PFMT protocol on UI symptoms in young nulliparous athletes using biomechanical models.	*Pad test*	**Intervention:** Supervised PFMT + DVD with educational material vs PFMT unsupervised and at home + DVD with educational material.	-
				PFMT protocol: Both groups underwent 8 weeks of treatment and received a DVD with biomechanical models that helped in the location, action and how to perform a correct PFM contraction. The DVD also featured the PFMT protocol divided into 4 phases: (1) stabilization, (2) strength, (3) power and (4) PFM contraction during sports activities, each phase lasting for 2 weeks.	

ICIQ-UI SF: International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form; PFM: pelvic floor muscles; PFMT: pelvic floor muscle training; SUI: stress urinary incontinence; UI: urinary incontinence.

unsupervised home-based PFMT protocol [31], and with a control group without intervention [28]. Da Roza et al. [30] applied the same PFMT protocol to all sample.

▶ **Table 3** shows the main results from selected studies. Three studies demonstrated a significant reduction in the UI frequency in the PFMT group [27, 29, 30], and there was a significant decrease in frequency when compared to the control group [27].

Regarding the UI amount, five studies showed a significant decrease in pre- and post-PFMT group [27–31] and two studies showed a significant decrease in PFMT group when comparing with the control group [27, 28]. Sherman, Davis and Wong (1997) [29] evaluated the amount of UI and the degree of urinary urgency, through ordinal variables that have a classification of the severity of the symptom elaborated by the authors themselves. The study found significant decrease in both groups (PFMT with and without biofeedback) in the pre- and post-intervention comparisons for the two variables, but without significant differences between groups.

The enuresis episodes were evaluated in one study through a question created by the authors and found a significant reduction in both study groups (PFMT with or without biofeedback) [29]

▶ **Table 4** presents the results of the PFM function and QoL. From the five selected studies, three assessed the function of PFM. Three different tools were used: manometer [28, 30, 31], modified Oxford Scale [31] and Self-Efficacy Scale of Broome (score A, B and total) [31]. Two studies found a significant increase in MVC of the PFM in the PFMT group when comparing before and after treatment [28, 30], and one study found a significant increase in PFMT group when comparing with the control group [28]. The same two studies assessed the VRP [28, 30], where Da Roza et al. found a significant increase in the PFMT group after the intervention. In the evaluation using the modified Oxford Scale and the Self-Efficacy Scale of Broome (score A, B and total), no significant differences were found in intra- and inter-group comparisons [31].

Two studies assessed the QoL of the incontinent women [28, 31]. The King´s Health Questionnaire (KHQ) and the CONTILIFE Questionnaires were the assessment questionnaires. None of them found a significant difference in intra- and inter-group comparisons in any domain or total score.

▶ **Table 2** demonstrate the PEDro scale scores applied to the selected RCTs. The score ranged from 5 to 7 points, where two studies scored 5 [27, 29] and one study scored 7 [28]. Only one study [28] was considered to have good methodological quality. For the two non-RCTs, the ROBINS-I scale was used (▶ **Table 5**), where one of the studies was classified as having a serious overall risk of bias [30] and the other as a critical overall risk of bias [31].

The CERT scores ranged from 5 to 9 (▶ **Table 6**). The highest scores were obtained by Da Roza et al. [30] and by Sherman, Davis and Wong [29] with 9 out of 19 points, followed by Pires et al. [28], Ferreira et al. [27] and Sousa et al. [31] with 7, 6 and 5 points, respectively. None of the authors scored in six items (6, 11, 14b, 15, 16a and 16b) and only four items (3, 4, 12 and 14a) were scored by all authors.

▶ **Table 2** shows that all published studies used different PFMT protocols. The duration of the training protocol ranged between eight and 16 weeks. The number of slow PFM contractions per day ranged from five to 30 times, they were sustained for five to 10 seconds and the relaxation time between contractions ranged from two to 10 seconds. The number of rapid contractions per day ranged from 120 to the number of series requested by the coach during training. Only Da Roza et al. [30] study asked the participants to perform the PFM contractions until fatigue.

All five studies associated educational actions or materials with PFMT [27–31]. The educational actions consisted of health education focused on the PFM [27], explanation about the PFMT [28], an education book and instructions on urination [29], or a DVD with biomechanical models that explain anatomy and the PFM contraction [30, 31]. In addition, one study associated the PFMT with bladder training and urinary urgency control, to be used when applicable [29]. This training consisted of a urination schedule that started every one hour and went on to every two hours. Regarding the control of voiding urgency, the participants were taught to perform three-second CVM to suppress urgency.

All studies applied PFMT protocol at home [27–31], two studies applied supervised PFMT [29, 31] and one associated the home environment with the athletes' training location in the protocol [28]. One study held meetings with participants every 15 days,

▶ **Table 3** Main results of urinary incontinence (UI) symptoms of the five studies included in the review.

Outcome	Author/year	Intra and/or intergroup analysis
Frequency of urine loss	DA ROZA et al., 2012	PFMT: P1 mean 1.6 (SD 1.5); P2 mean 0.1 (SD 0.4)*
	FERREIRA et al., 2014#	PFMT[a]: mean -0.3 (SD 0.50)* *vs* control group: mean -0.1 (SD 0.44)
	SHERMAN; DAVIS; WONG, 1997	PFMT without biofeedback: P1 mean 15.72 (SD 10.71); P2 mean 5.25 (SD 7.24)* *vs* PFMT with biofeedback: P1 mean 7.27 (SD 7.44); P2 mean 2.90 (SD 6.53)*
Amount of urine loss	DA ROZA et al., 2012	PFMT: P1 mean 2.6 (SD 1.5); P2 mean 0.3 (SD 0.8)*
	FERREIRA et al., 2014#	PFMT[a]: mean -2.0 (SD 1.28)* *vs* control group: mean -0.2 (SD 0.41)
	PIRES et al., 2020#	PFMT: P1 mean 2.71 (SD 2.14); P2 mean 1.29 (SD 1.70)* *vs* group control: P1 mean 1.83 (SD 2.40); P2 2.00 (SD 1.67)
	SOUSA et al., 2015	PFMT with supervision: P1 mean 1.34 (SD 0.4); P2 mean 0.93 (SD 0.3)$*vs* PFMT without supervision: P1 mean 1.08 (SD 0.1); P2 mean 1.07 (SD 0.2)
Enuresis episodes	SHERMAN; DAVIS; WONG, 1997	PFMT without biofeedback: P1 mean 1.19 (SD 1.28); P2 mean 0.25 (SD 0.45)* vs PFMT with biofeedback: P1 mean 0.65 (SD 0.94); P2 mean 0.26 (SD 0.54)*

Statistically significant difference between groups ($p < 0.05$); * Statistically significant difference within groups ($p < 0.05$); $ Statistically significant difference within groups ($p = 0.05$); SD: standard deviation; [a] Mean and SD of the variation (final-initial) of the values; P1: pre-intervention; P2: post-intervention; PFMT: pelvic floor muscle training.

▶ **Table 4** Main results of pelvic floor muscle (PFM) function and quality of life (QoL) of the three studies included in the review.

Outcome	Author/year	Intra and/or intergroup analysis
PFM function - manometry (MVC, cmH_2O)	DA ROZA et al., 2012	PFMT: P1 mean 73.4 (SD 24.9); P2 mean 89.8 (SD 19.1)*
	PIRES et al., 2020#	PFMT: P1 mean 60.80 (SD 19.72); P2 mean 78.75 (SD 18.36)* *vs* control group: P1 mean 55.68 (SD 29.12); P2 55.13 (SD 30.97)
	SOUSA et al., 2015	PFMT with supervision: P1 mean 34.61 (SD 0.5); P2 mean 54.59 (SD 11.2) *vs* PFMT without supervision: P1 mean 41.23 (SD 0.0); P2 mean 48.23 (SD 0.0)
PFM function - manometry (VRP, cmH_2O)	DA ROZA et al., 2012	PFMT: P1 mean 38.4 (SD 15.7); P2 mean 55.8 (SD 9.0)*
	PIRES et al., 2020	PFMT: P1 mean 17.33 (SD 7.74); P2 mean 12.31 (SD 3.70) *vs* control group: P1 mean 16.18 (SD 15.71); P2 13.67 (SD 8.00)
PFM function – vaginal palpation (modified Oxford Scale)	SOUSA et al., 2015	PFMT with supervision: P1 mean 3.50 (SD 0.7); P2 mean 4.50 (SD 0.7) *vs* PFMT without supervision: P1 mean 4.00 (SD 0.0); P2 mean 4.00 (SD 0.0)
PFM function – questionnaire (Broome Self-efficacy Scale)	SOUSA et al., 2015	Score A = PFMT with supervision: P1 mean 46.25 (SD 48.1); P2 mean 75.71 (SD 17.9) *vs* PFMT without supervision: P1 mean 61.90 (SD 45.0); P2 mean 71.43 (SD 25.1)
		Score B = PFMT with supervision: P1 mean 69.45 (SD 17.5); P2 mean 75.00 (SD 12.5) *vs* PFMT without supervision: P1 mean 71.48 (SD 17.2); P2 mean 65.93 (SD 25.7)
		Total score = PFMT with supervision: P1 mean 57.85 (SD 32.2); P2 mean 75.36 (SD 15.0) *vs* PFMT without supervision: P1 mean 66.69 (SD 30.5); P2 mean 68.68 (SD 25.2)
Quality of life	PIRES et al., 2020	Global score (KHQ) = PFMT: 6.35 (5.19) *vs* control group: 8.80 (4.62)
		Personal limitations and daily life (KHQ) = PFMT: 17.86 (14.17) *vs* control group: 24.31 (12.20)
		Emotions and personal relationships (KHQ) = PFMT: 1.19 (2.03) *vs* control group: 2.08 (3.49)
		Urinary symptoms (KHQ) = PFMT: 0.00 (0.00) *vs* control group: 0.00 (0.00)
		Symptom Severity Scale (KHQ) = PFMT: 6.93 (5.16) *vs* control group: 6.06 (3.32)
		General perceptions of health (KHQ) = PFMT: 7.14 (12.20) *vs* control group: 8.33 (12.91)
		Impact of incontinence (KHQ) = PFMT: 19.05 (17.82) *vs* control group:16.67 (27.89)
	SOUSA et al., 2015	CONTILIFE total score = PFMT with supervision: P1 mean 9.45 (SD 1.0); P2 mean 9.79 (SD 0.4) *vs* PFMT without supervision: P1 mean 9.26 (SD 1.2); P2 mean 9.45 (SD 0.9)
	SOUSA et al., 2015	CONTILIFE question 28 = PFMT with supervision: P1 mean 1.50 (SD 0.6); P2 mean 1.30 (SD 0.6) *vs* PFMT without supervision: P1 mean 1.30 (SD 0.6); P2 mean 1.67 (SD 1.2)

Statistically significant difference between groups ($p < 0.05$); * Statistically significant difference within groups ($p < 0.05$); CONTILIFE: Questionnaire d'évaluation de la Qualité de Vie liée à l'incontinence urinaire de la femme; KHQ: King's Health Questionnaire; MVC: maximum voluntary contraction; P1: pre-intervention; P2: post-intervention; PFM: pelvic floor muscles; SD: standard deviation; VRP: vaginal resting pressure.

▶ **Table 5** Risk Of Bias In Non-randomized Studies – of Interventions (ROBINS-I) scores of the two non-randomized intervention studies.

	Con-founding	Selection of participants	Classification of interventions	Deviations from intended interventions	Missing data	Measurement of outcomes	Selection of the reported result	General
DA ROZA et al., 2012	Moderate	Low	Serious	Moderate	Low	Serious	Serious	Serious
SOUSA et al., 2015	Moderate	Low	Critical	Moderate	Low	Serious	Serious	Critical

Low risk: comparable to a well-executed randomized trial; Moderate risk: valid for a non-randomized trial but cannot be considered comparable to a well-performed randomized trial; **Serious risk:** has some major problems; **Critical risk:** too problematic in this domain to provide any useful evidence on the effects of the intervention; **Overall risk of bias:** equal to the most severe level of bias found in any domain.

where the physiotherapist showed the new exercises for the next step [30]. To assess the participants' progress and adherence to the home-based treatment, one study requested the completion of an exercise diary [30] and another performed weekly visits, both at home and after training [27].

Three studies progressed the PFMT protocol in phases [28, 30, 31]. The intensity of the PFMT protocols progressed according to the positions adopted, reducing the interval time between each contraction, increasing the number of repetitions and/or sustained contraction time.

Discussion

Despite the heterogeneity in the outcome measures used to assess UI symptoms, all five studies showed a reduction in the amount [27–31], and three studies showed a decrease in the frequency of UI [27, 29, 30] in the PFMT group after the intervention. The symptoms of urinary urgency and the enuresis episodes were evaluated in one study, and the authors found a significant decrease in both groups (PFMT with and without biofeedback) [29].

Regarding the PFM function, two of the five studies [28, 30] found a significant increase in MVC pre-and-post-PFMT group, and the first study also demonstrated a significant increase in MVC

▶ **Table 6** Consensus on Exercise Reporting Template (CERT) scores of the five studies included in the review.

		DA ROZA et al., 2012	FERREIRA et al., 2014	PIRES, et al., 2020	SHERMAN; DAVIS; WONG, 1997	SOUSA et al., 2015
1	**Detailed description of exercise equipment (e. g. weights, treadmill, ergometer, etc.)**	Y	NA	N	Y	N
2	**Detailed description of instructor expertise, qualifications, and/or training**	Y	N	N	Y	N
3	**Describe whether exercises are performed individually or in a group**	Y	Y	Y	Y	Y
4	**Describe whether exercises are supervised or unsupervised; how they are delivered**	Y	Y	Y	Y	Y
5	**Detailed description of how adherence to exercise is measured and reported**	Y	N	N	N	N
6	**Detailed description of motivation strategies**	N	N	N	N	N
7a	**Detailed description of decision rule(s) for determining exercise progression**	Y	N	N	N	N
7b	**Detailed description of how exercise program was progressed**	Y	N	Y	N	N
8	**Detailed description of each exercise to enable replication**	N	N	Y	N	N
9	**Detailed description of any home program component**	N	N	N	Y	N
10	**Describe any non-exercise components, e. g. education, cognitive behavioral therapy, etc**	N	Y	N	Y	Y
11	**Describe the type and number of adverse events that occur during exercise**	N	N	N	N	N
12	**Describe the setting in which the exercises are performed**	Y	Y	Y	Y	Y
13	**Detailed description of exercise intervention, e. g. reps, sets, sessions**	N	Y	Y	Y	N
14a	**Describe whether the exercises are generic (one size fits all) or tailored**	Y	Y	Y	Y	Y
14b	**Detailed description of how exercises are tailored to the individual**	N	N	N	N	N
15	**Describe the decision rule for determining the starting level, e. g. beginner, intermediate, advanced, etc**	N	N	N	N	N
16a	**Describe how adherence or fidelity to the intervention is assessed/measured**	N	N	N	N	N
16b	**Describe the extent to which the intervention was delivered as planned**	N	N	N	N	N

N: no; NA: not applicable; Y: yes.

when compared with the control group [28]. The same two studies assessed the VRP, and one found a significant VRP increase in the PFMT group [30]. Indeed, several studies with women of the general population demonstrated an increase of the PFM maximal strength after PFMT [32–34]. It is known that a strong pelvic floor positioned at an optimal level within the pelvis can be a crucial factor in counteracting the increases in IAP that occur during high-impact activities [13]. The rationale for using the PFMT is that enhanced by hypertrophy of the muscles which will increase the stiffness of the PFM and connective tissue. Associated to that, Pires et al. [35] found that the higher the MVC values, the better the QoL in sportswomen. So, PFMT will enhance the PFM structurally and also improve the QoL of athletic women.

Studies in the literature demonstrated [11, 36, 37] significantly worse QoL in incontinent women who practice high-impact sports. Pires et al. [38] found that women who practice high-impact sports had a greater impact on the QoL than those who practice low-impact ones. Dakic et al. [39] also demonstrated that women with symptoms of PFM disorders in high-impact sports are the most interrupted exercise (42 %) when compared to women engaged in low-impact sports (21 %). These results may be related to the fact that athletes consider that UI has implications for their sports performance. They end up using strategies to hide urine loss and omit the symptoms of this dysfunction to health professionals, impacting their QoL [40]. Curiously, the two studies that assessed the QoL [28, 31], demonstrated a high QoL among the incontinent women pre and post-intervention. These results can be explained due to

the women report their bladder problem as little affect their exercise [28], or due to the little amount of UI [31]. In addition, a systematic review [41] demonstrated that physical activity practitioners generally have a better perception of QoL.

The studies included feature a variety of study designs, PFMT protocols, comparison groups, and outcome measures. The CERT score ranged from 5 to 9, which represents that most RCTs were described in insufficient detail to allow their optimal translation into clinical practice. In our review, the period of the PFMT intervention ranges from eight to 16 weeks. García-Sánchez et al. [42] in their meta-analysis, found that six to 12 weeks or ≥ 24 sessions are ideal to achieve an decrease in urine loss because there is an improvement in muscle tone and automatic motor control of PFM. All studies included in this review were carried out at home and some characteristics of the PFMT protocol were not described, such as the duration and/or weekly frequency of sessions, number of series and repetitions, contraction and relaxation time, and adopted positions. The absence of this information makes it difficult to replicate the protocol and discuss whether the characteristics of the training are adequate or insufficient to improve the UI symptoms in female athletes.

Among the studies included, only one added an adjuvant treatment to PFMT [29]. This study used biofeedback and found significant improvement in the group that associated PFMT with biofeedback in UI symptoms (frequency and amount of UI, enuresis episodes, and degree of urinary urgency). A recent systematic review [42] demonstrated greater effectiveness in SUI treatment when using biofeedback, and they recommend applying PFMT with biofeedback or accessories to treat SUI.

This systematic review has some limitations, the first being that the studies selected for review had different study designs, where three are RCTs, and two are non-RCTs. In addition, some PFMT information (number of repetitions, contraction and interval time, exercises performed, use of accessories, among others) are not described in the methodology of the included articles, making it difficult to properly replicate the PFMT protocol and verify the real effect in UI symptoms in these women. Also, only five studies were included, the results of this study should be interpreted with caution. There is a need to carry out more studies in this area, to clarify the best way to apply the PFMT in incontinent women who practice high-impact sports.

Conclusion

PFMT can significantly reduce UI symptoms and the frequency and amount of UI, and improve the PFM function in female athletes. The urinary urgency and enuresis episodes can also be significantly reduced with PFMT associated or not with biofeedback. At the end of the PFMT, the MVC and the VRP were significantly increase in these women, however, the function of the PFM assessed by palpation or questionnaire did not improve. Despite evidence showing that UI symptoms can negatively impact the QoL of female athletes, two studies assessed the QoL and they demonstrated that UI does not affect their lives. There is still a need for RCTs with high methodological quality that investigate the effect of PFMT in women who practiced high-impact sports.

Conflict of Interest

The authors declare that they have no conflict of interest.

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