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ORIGINAL ARTICLE

Pelvic floor muscle training to improve urinary incontinence in young, nulliparous sport students: a pilot study

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Abstract
Introduction and hypothesis Urinary incontinence (UI) is prevalent in sport students. We hypothesized that pelvic floor muscle training (PFMT) can improve pelvic floor muscle (PFM) strength and symptoms of UI in this group of physically active women.
Methods Sixteen sport students with UI participated in this pre-post test pilot study. However, only seven of them, mean age 20.0±0.8 years, completed the 8-week program. Activity level was measured by the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The outcome measure was the International Consultation on Incontinence Questionnaire-Short Form (ICIQ UI SF). PFM strength was measured by manometry as maximum voluntary contraction (MVC).
Results Vaginal resting pressure improved by 17.4 cmH_2O (SD 6.7), p=0.04 and MVC by 16.4 cmH_2O (SD 5.8), p= 0.04. ICIQ UI SF score, frequency, and amount of leakage showed statistically significant improvement.
Conclusions PFMT increased PFM strength and reduced frequency and amount of UI episodes in sport students that completed an 8-week PFMT program. Randomized controlled trials are warranted to confirm these results.

Keywords Exercise · Manometry · Pelvic floor muscle training · Rehabilitation · Sport students · Urinary incontinence

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Introduction

Urinary incontinence (UI) is defined by the International Continence Society (ICS) as the complaint of any involuntary loss of urine [1]. Published prevalence rates of all types of UI in adult women vary between 45 and 53 % [2]. Incontinence may negatively impact quality of life (QOL) by causing anxiety, embarrassment, and reduced participation in social activities [3]. Still, it is believed that UI is mainly a problem for the elderly and parous women, although, in recent studies, UI has also been reported among young, physically fit nulliparous women [4–8].

Bø et al. [9] found that 26 % of young physical education students reported UI during different forms of physical activities, and the same prevalence was found in group fitness instructors including Pilates and yoga instructors [10]. Nygaard et al. reported a 28 % prevalence in college athletes [11].

Factors contributing to UI in young nulliparous women are not fully understood. Weak connective tissue combined with high-intensity and high-impact activity may unmask the condition [11, 12]. A heavy training routine has been considered a potential risk factor due to the increase of the intra-abdominal pressure and the impact from ground reaction forces, which may contribute to stress urinary incontinence (SUI). Ree et al. found that in young nulliparous women (mean age 24±1.7 years), after one bout of 90 min of strenuous physical activity, the mean maximum voluntary contraction (MVC) pressure decreased by 17 %, indicating pelvic floor muscle fatigue [13].

Several randomized controlled trails (RCTs) and systematic reviews have concluded that pelvic floor muscle training (PFMT) is an effective therapy for SUI. However, a search of PubMed did not reveal any RCTs of PFMT in young nulliparous sportswomen or female elite athletes. Only one recent case study reported results from three volleyball players [14]. The purpose of the present study was to evaluate the effect of a comprehensive PFMT program on UI symptoms in young nulliparous sport students.

Materials and methods

Design and participants

This was a pre-post test pilot study. Between August 2010 and February 2011, 119 physically active sport students answered a questionnaire on UI. At the end of the questionnaire they were invited to participate in a PFMT study, and 24 agreed to participate. After screening, 16 students met the inclusion criteria.

Inclusion criteria were being nulliparous, incontinent, and performing high levels of physical activity classified according to the International Physical Activity Questionnaire-Short Form (IPAQ-SF) [15]. Exclusion criteria included being pregnant, having had previous pelvic surgery, neurological problems, ongoing urinary tract infections, pelvic organ prolapse, or inability to contract the pelvic floor muscle (PFM). In this study the sport students that had a complaint of any involuntary loss of urine were classified as incontinent, as recommended by the ICS [1]. The question used for the prevalence was question 1 in the International Consultation on Incontinence Questionnaire (ICIQ).

Female sport students were recruited from the Faculty of Sports of the University of Porto, Portugal. The study was approved by the São João Hospital Ethics Committee, Porto, Portugal.

The sample characteristics are summarized in Table 1. Table 2 shows the type of exercise performed by each female sport student. All seven participants concluded PFMT for a period of 8 weeks and were assessed before and after the intervention period.

Table 1 Baseline demographics of incontinent nulliparous female sport students

Data are presented as means±standard deviation

BMI body mass index

	$n=7$
Mean age (years)	20.0 (±0.8)
Mean weight (kg)	53.1 (±5.5)
Mean BMI (kg/m^2)	20.8 (±1.1)
Mean age at menarche (years)	12.1 (±0.9)
Mean hours of training/week	5.0 (±1.1)

Data collection

Initially each sport student answered a tree section questionnaire; the first part was designed to investigate the demographic characteristics: age, weight, height, number of pregnancies, age of menarche, ethnicity, education, type of sport practiced, and amount of daily training. In order to assess the physical activity level of the sport students the IPAQ-SF was applied. Women reaching a minimum total physical activity of at least 3,000 metabolic equivalent (MET)-min/week (4 h/week—vigorous-intensity activity) were considered as having high levels of physical activity [15].

The third part contained the International Consultation on Incontinence Questionnaire-Short Form (ICIQ UI SF) [16], which is a simple, brief, and specific questionnaire developed by the ICS, translated and validated for the Portuguese language [17]. The ICIQ UI SF consists of four items: (1) frequency of UI, (2) amount of leakage, and (3) overall impact of UI. From the sum of these three items, the total ICIQ-SF score (between 0 and 21) was calculated. A fourth item included eight questions related to symptoms determining the type of UI.

Measurement of ability to contract, vaginal resting pressure, and MVC

Vaginal palpation was used to assess correctness of the voluntary PFM contraction, and PFM strength was measured as the MVC using the Peritron perineometer (Cardio Design Pty Ltd, Oakleigh, VIC, Australia). The examinations were performed in a crook lying position, and the participants were instructed to contract their PFM with maximum perceived effort and to hold the contraction for

Table 2 Present main sports activities performed by each of the female sport students

	Type of exercise
Sport student 1	Gymnastics
Sport student 2	Gymnastics
Sport student 3	Trampoline
Sport student 4	Figure skating
Sport student 5	Synchronized swimming
Sport student 6	Handball
Sport student 7	Handball

2–3 s. No visible contractions of the outer pelvic muscles were allowed, and only contractions with simultaneous inward movement of the probe were registered as valid measurements of correct contractions [18]. The Peritron has been tested to assure its reliability and has been found to have very good intra-reliability when used to measure vaginal resting pressure and MVC [19]. Ferreira et al. also demonstrated moderate inter-rater reliability of the measurement tool [20].

Intervention

The seven participants completed an 8-week exercise program. The intervention program was mediated by three physiotherapists, specialized in pelvic floor rehabilitation.

The protocol consisted of four stages, conducted during 2 weeks each: (1) awareness of PFM based on feedback during vaginal palpation, (2) contraction of the PFM in different positions with progressive weights added to the lower extremities, (3) attempts to contract the PFM during running and walking activities, and (4) attempts to contract the PFM during sports activities. Meetings with the participants were held every 15 days, where the physiotherapists taught the new exercises to be performed at the next stage. The participants were asked to perform the exercises every day until fatigue. An explanatory DVD illustrating the exercise program was provided to the participants to be used for home exercise. The sport students were asked to write an exercise diary, reporting their progress and adherence to the project.

Statistical analysis

Statistical analyses were performed with SPSS software, Version 17. Background variables are presented as numbers or means with standard deviations (SD). Comparison between the group that gave up and the group that completed the exercise program was performed with the independent *t* test. The Wilcoxon test was performed to evaluate differences between pre and post test. A p value of <0.05 was considered statistically significant.

Results

Seven sport students completed the training program. All seven participants reported SUI. Most of them were incontinent during physical activity and one reported mixed UI (Table 3).

There were no significant differences in demographic characteristics between the sport students that dropped out of the program and those who completed the 8 weeks, with $p>0.05$ to age, BMI, age at menarche, and hours of training. A comparison of PFM resting tone and MVC indicated no statistical differences between the two groups. However, ICIQ indicated that participants who completed the program had a significantly greater frequency of leakage (1.6±1.5 vs 1.0±0.0) and also a larger impact on their QOL (2.9±3.8 vs 0.8±0.9) compared with the sport students that dropped out of the exercise program ($p=0.016$ and $p=0.007$, respectively).

Table 3 Type of UI among nulliparous female sport students (ICIQ-SF), $n=7$. Multiple answers possible

	n
Loss of urine during coughing/sneezing	4/7
Loss of urine during physical activity	6/7
Loss of urine before reaching the toilet	1/7
Loss of urine after finishing urinating and being dressed	0
Loss of urine for no obvious reason	0
Loss of urine when asleep	0
Loss of urine all the time	0

All participants were able to perform a correct PFM contraction assessed by vaginal palpation. Table 4 shows a statistically significant improvement in vaginal resting pressure and MVC after the 8-week training period.

The amount of urine loss was classified as small in most cases (Table 5). Five of the sport students reported that UI had a negative impact on their QOL; however, this negative effect remained mostly at the mild level. Nevertheless, one athlete reported being very uncomfortable with the loss of urine during the exercise (ICIQ score=21) and for this reason thought of quitting the sport.

As displayed in Table 5, there was no significant difference in QOL before and after the intervention. However, a significant improvement in the frequency and amount of UI was found. The improvement from baseline to the end of intervention in ICIQ scores for each sport student can be seen in Table 6. Of the 16 participants, 7 completed an 8-week PFMT program and adhered to the prescribed protocol during the four stages. Six of these seven were cured according to the ICIQ score (Table 6).

Table 4 Changes in vaginal resting pressure and MVC (cmH_2O) in seven female sport students before and after an 8-week PFMT course

	Mean scores (SD)		*p* value
	Before	After	
Vaginal resting pressure	38.4±15.7	55.8±9.0	0.043[a]
MVC	73.4±24.9	89.8±19.1	0.043[a]

MVC maximum voluntary contraction

[a] Wilcoxon signed rank test

Table 5 Frequency, amount, impact on QOL, and the ICIQ-SF score in seven female sport students before and after an 8-week PFMT course

Characteristic	Mean scores (SD)		*p* value
	Before	After	
Frequency of leakage	1.6 (±1.5)	0.1 (±0.4)	0.020[a]
Amount of leakage	2.6 (±1.5)	0.3 (±0.8)	0.020[a]
Impact on QOL	2.9 (±3.8)	0.9 (±2.3)	0.066[a]
ICIQ-SF score	4.08 (±6.0)	0.75 (±2.6)	0.027[a]

[a] Wilcoxon signed rank test

Discussion

This pilot study demonstrated that an 8-week training protocol using progressive PFMT in combination with functional training resulted in significant improvements in vaginal resting pressure and in MVC. Six of seven sport students that completed the program reported to be cured after the intervention.

This is one of the few studies available in this population, and although PFMT is effective in the general population, it has been suggested that it may be more difficult to treat physically active women than their more sedentary counterparts due to their frequent exposure to increased abdominal pressure and increased ground reaction force. Hence, the PFM probably needs to be much stronger in exercisers and elite athletes [21].

To date, there is little knowledge about PFM function in elite athletes. Hay reported that the maximum vertical ground reaction forces during landing in long jumps can reach 16 times the athlete's body weight [22]. Thus, one would anticipate that the pelvic floor of athletes is required to be much stronger than in the normal population to counteract these forces. Our results demonstrated that sport students have higher average MVC values (73.4±24.9) when compared to university students (45.3±17.7) with similar demographic characteristics [20]. However, Bø et al. measured PFM function in sport and physical education students, with and without UI, and did not find any difference in PFM strength [23]. This indicates that heavy lifting and strenuous activity may promote SUI in women already at risk, e.g., women with weak collagen tissue [11, 24].

Some studies have found that a third of women with pelvic floor dysfunction are not able to contract the PFM correctly [21, 25]. In this pilot study we used vaginal palpation at the first evaluation to teach and confirm the ability to perform a correct contraction. A validated method for measuring PFM strength and endurance was used and significant improvements of vaginal resting pressure and MVC were found [19].

According to Chiarelli et al., the most important prognostic factor for PFMT efficacy is the adherence to the training protocol [26]. The participants who completed the present study adhered to the program at a satisfactory level. Severity of urine loss has been found to be a predictor for adherence. However, in the present study the urine loss was described as sporadic and small for most of the sport students. This may explain the high dropout rate—nine sport students dropped out of the training program. Another reason for the high dropout may be the nature of the training program which was time consuming, lasting for 60 min at each visit, and the need for the participants to conduct the program at the gym with the need for specific equipment. Additional limitations of the study were a small sample size and most importantly a nonrandomized design. However, as there are no RCTs on the effect of PFMT in sport students or elite athletes, the results of the present study may serve as a pilot for future high-quality RCTs and as a base for power calculations.

As far as we have ascertained the only published study on the effect of PFMT on sportswomen was a case study addressing the outcome of 4 months treatment for UI in three female volleyball players [13]. The results indicated that an individualized PFM rehabilitation program including biofeedback, functional electrical stimulation, and PFMT with and without vaginal cones could reduce UI [14]. Our results are in line with the above-mentioned study, and the outcome of our study was achieved within 8 weeks.

High prevalence rates of UI have been found in female elite athletes, especially in those performing high impact activities such as gymnastics, trampoline jumping, track and field, and ball games [11, 27]. In the present study, the sport students participating in sports with the greatest impact had a higher ICIQ score, and the one not improving was a gymnast.

UI is socially embarrassing also in sportswomen. Eliasson et al. studied a group of female ex-trampolinists (n=305) and found that 35 % were affected in daily life, 53 % reported to be psychologically affected, and 12 % stopped exercising because of UI [28]. In the present study the participant with the higher values of the ICIQ score reported embarrassment and

Table 6 Percentage of exercise adherence in four different stages and the ICIQ-SF score before and after an 8-week PFMT course for each sport student

	Stage 1	Stage 2	Stage 3	Stage 4	ICIQ-SF score	
					Before	After
Sport student 1	72 %	43 %	85 %	72 %	4	0
Sport student 2	57 %	29 %	60 %	57 %	9	9
Sport student 3	72 %	60 %	85 %	72 %	21	0
Sport student 4	72 %	57 %	72 %	57 %	3	0
Sport student 5	85 %	57 %	50 %	45 %	3	0
Sport student 6	80 %	43 %	60 %	72 %	4	0
Sport student 7	85 %	29 %	57 %	55 %	5	0

desire to give up the sport due to SUI. Hence, although UI itself does not cause significant morbidity or mortality, it may lead to inactivity.

PFMT has grade A evidence to be effective in treatment of SUI and mixed UI and is recommended as first-line treatment for UI [12]. This pre-post test pilot study indicates that it is also possible to obtain a positive outcome in a group of physically active nulliparous female sport students. There is, however, an urgent need for an RCT of high methodological quality and with use of additional methods such as pad testing during physical activities to confirm these results.

Conclusions

The present pilot study indicates that young nulliparous female sport students adhering to a PFMT program may be cured of stress UI. Future high-quality RCTs are necessary to confirm these results.

Conflicts of interest None.

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