Integrating Pelvic Health and Orthopedic Programs to Treat Incontinence at the Community Level for Female Runners: A Pilot Study

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ABSTRACT

Background: The female athlete population is at an increased risk for urinary incontinence. Few studies have investigated the use of a generalized home exercise program (HEP) at the community level to treat incontinence in sports, particularly running.

Objective: This study investigated whether a 1-time pelvic health (PH) workshop with a generalizable HEP had positive changes in incontinence at 2-week and 6-month follow-ups for female runners.

Study Design: Pilot study.

Methods: Participants attended a workshop about PH and received a PH- and orthopedic-based HEP. A blinded assessor evaluated overall trunk strength (CoreFirst® Strategy, 0-5 scale) pre- and postworkshop. Questionnaires evaluated the frequency of leakage during activities. Time points were baseline (preworkshop) and 2-week and 6-month follow-up. Paired *t* tests, McNemar-Bowker tests, and Cochran Q with Dunn post hoc tests were used for comparisons.

Results: Twenty-two participants enrolled in the study (age: 44 ± 11 years; body mass index: 22 ± 2 kg/m^2). Trunk weakness improved after the workshop by 2 stages. Home exercise program adherence was 86% and 55% through 2 weeks and 6 months, respectively. Significant improvements in the incidence of reported incontinence were found after 2 weeks for jumping (41 to 5%, P = .006), landing from jumping (46 to 9%, P = .003), coughing (64 to 14%, P = .001), sneezing (59 to 14%, $P <$ .001), and walking to bathroom (59 to 32%, P = .016), and after 6 months for coughing (64 to 14%, P = .001) and sneezing (59 to 23%, P = .006).

Conclusions: Educating female runners and providing a generalized HEP focused on PH had immediate positive significant changes in overall trunk strength and incontinence at 2 weeks and generally maintained through 6 months.

See Video Abstract, Supplemental Digital Content 1, available at: http://links.lww.com/JWHPT/A91.

Key Words: athletes, community-based research, pelvic floor, urinary leakage, women

INTRODUCTION

The prevalence of pelvic health dysfunction is approximately half of the female athlete population,[1–4] who are almost 3 times more likely to experience urinary incontinence (UI) than nonathlete females.[5] Certain activities, especially those that include jumping and running, put women at higher risk of developing UI.[6] Although the prevalence is high, reporting incontinence is low, with more than 90% of high school and college-aged women reporting "never speaking about their condition to anyone" and having "no knowledge of preventative measures."[1,7] Urinary incontinence can greatly affect the quality of life and overall health of a woman. Given the well-documented benefits of regular physical activity on general and emotional health,[8] as well as cognitive performance in female athletes,[8] facilitating a rewarding sports participation experience should be a priority for primary care and sports

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medicine specialists.[3] In particular, stress urinary incontinence (SUI) is reported as a barrier to women's participation in sport and fitness activities and may be a threat to women's health, self-esteem, and well-being.[3,9,10] Embarrassment and discomfort are significant reasons reported for women leaving sports altogether.[11,12] Currently, there are no standard recommendations or training programs for the treatment of incontinence in female athletes. Breaking barriers to fitness—particularly resolving incontinence—needs to be a priority of women's health care providers.

Previous literature has shown that SUI is preventable and treatable with pelvic floor muscle (PFM) exercises,[9,13–16] strengthening the pelvic floor to withstand the increased demand of high-impact sports.[9,17] With the large number of girls and women participating in sport and strenuous training regimens, educating the public about prevention, maintenance, and treatment options for incontinence needs to be a priority of health care providers—in particular, women's health physical therapists—as they specialize in the conservative treatment for SUI.

Although traditional preventative sport training programs tend to focus on major orthopedic principles of gross strength training and flexibility for sport, incorporating foundational principles of pelvic health to prevent incontinence is lacking. Evidence suggests that PFMs are not strengthened during general training but require specific exercises, especially for higher-impact sports.[17] For instance, while the relationship of breath, the diaphragm, thoracic cage, and PFMs is understood in research and clinical settings,[18–21] it has yet to be fully incorporated and focused on at the population level, in particular, in the sports community. When considering the fact that runners are experiencing increases in intra-abdominal pressure[22,23] throughout their activity and for extended periods of time, the benefit of teaching at the community level proper recruitment of muscles and mechanics for breathing during activities of daily living (ADLs) and exercise could be exponential on lowering the prevalence of incontinence in female athletes.

Another consideration is the connection of the surrounding muscles to the PFMs.[24] The bony and muscular pelvis is highly interconnected to the hip and gluteal musculature provides support to the internal organs and core muscles.[24] It is well understood that the PFMs activate automatically and differentially depending on postural and extremity movements,[25] with altered activation in those with incontinence.[26] With the current knowledge that incontinence in female athletes is affected by more than just PFM weakness and is due to the combined effects of increased intra-abdominal pressure with impact, rotational movements, and speed of contraction order,[27] it is critical that HEPs for female athletes incorporate all key aspects known to affect incontinence.

Very few studies have investigated the use of a general HEP to treat incontinence in sports, including running.[28] To date, no studies have investigated developing pelvic health prevention and maintenance programs and tested their efficacy in resolving SUI for female sports programs, particularly in those sports that have the highest rates of jumping, high-impact landings, and running.[9,10,29,30] Thus, there is a need for more research on PFM function during physical activity and the effect of PFM training in female athletes.

The aim of this study is to determine the feasibility and efficacy of a generalized HEP, focused on pelvic health, and the changes reported in SUI, trunk weakness, and overall strength in female runners at 2-week and 6-month follow-up. The primary hypothesis is that a 1-time, 2-hour, in-person educational workshop with an HEP for female runners will improve SUI and strength both in the short term (2 weeks) and the long term (6 months).

METHODS

Participants

This study was approved jointly by the institutional review boards of Notre Dame de Namur University and University of the Pacific. Solicitation took place through social media and email to a running group.

Participants who agreed to be contacted were sent an initial questionnaire. Informed consent was obtained for all participants in the study. To be included in the study, all participants had to be 18 years of age; if younger than 18 years, the participant(s) needed to have a signed consent form by their legal guardian. If pregnant or less than 6 weeks postpartum, the participants needed to have prior approval of participation by their provider. Understanding of the English language both written and verbal was needed. Although males were welcome to attend the workshop, their data were excluded from the study.

Preintervention Measurements

Before attending the workshop (intervention), the participants completed a demographic questionnaire for basic identifying information, competitive running, and sport history, and known variables associated with incontinence (eg, pregnancy/postpartum history including mode of delivery, caffeine intake, hormone replacement therapy). In addition, they completed a descriptive questionnaire about the prevalence of UI during running, activities of daily life, and recreational sports. Although the incontinence questionnaire has yet to be validated, it is based on the information provided in the pivotal 1994 study in female athletes[29] that asked about frequency of episodes during sport and daily activities.[29] Based on clinical observation, it also included running specific

incontinence questions such as frequency of episodes "during running" and "while running, specifically as approaching, at, or after the finish line" to help capture the specificity of timing of loss of urine during running. The participants rated frequency of incontinence as never, just once, rarely, sometimes, frequently, or always. The questionnaire also asked whether they had a history of orthopedic injury in the hip, knee, ankle, foot, or shoulder (see Figure 1).

A preintervention general trunk strength assessment was measured using the Institute of Physical Art's "Trunk Responsiveness Assessment: Lumbar Protective Mechanism Test (LPMT)."[31] Although yet to be validated, this test is widely taught and used as a foundational clinical assessment technique during neurological and orthopedic physical therapy evaluations.[31] The foundation of the LPMT is grounded in proprioceptive neuromuscular facilitation, which emphasizes treating dysfunctions, reducing symptoms, improving the distribution of forces, and reducing inherent functional stresses caused by poor neuromuscular control,[31] and is a foundational assessment and treatment technique within the physical therapy field.[31] The LPMT is used to assess the "ability of the trunk muscles to respond and maintain a stable posture against external resistance." As the trunk is the main testing site, the test gives the clinician a general understanding of areas of weakness (break points) within the patient's trunk stability/strength.

Participants placed 1 foot forward while the assessor manually evaluated for weakness using a 12-point, 0 to 5 scale (Figure 2). Zero equated to the ability to stand in the position and unable to accept resistance; 1 was a loss of 2 feet balance (needed to step to the side) when resistance was applied for 5 seconds to bilateral shoulders; 2 was 1 foot loss of balance upon applied resistance; 3 was able to hold against some resistance (<5 seconds) and then lost 1 foot balance; 4 was able to hold against resistance for 5 seconds but had a break in chain (rotation or flex/extension in trunk or shoulder or hip) and kept balance; and 5 was no loss of balance and no movement/break within chain. Plus and minus grades were assigned when the participant was either above or below the level but did not meet criteria for full leveling (ie, 4+ was able to hold against resistance for 5 seconds and had a minor break in chain while keeping balance; 4− was able to hold against resistance for 5 seconds and had a major break in chain while keeping balance). Trunk strength was assessed at the beginning and end of the workshop by the evaluating PT who was blinded to the participant's scores. Assessor went to each participant, tested his or her trunk strength, and then reported to the research assistant who recorded the value.

Intervention

The intervention was a 2-hour workshop, led by a pelvic health physical therapist (PHPT), who focused on training the inner core muscles for runners. It consisted of a 45-minute educational session about

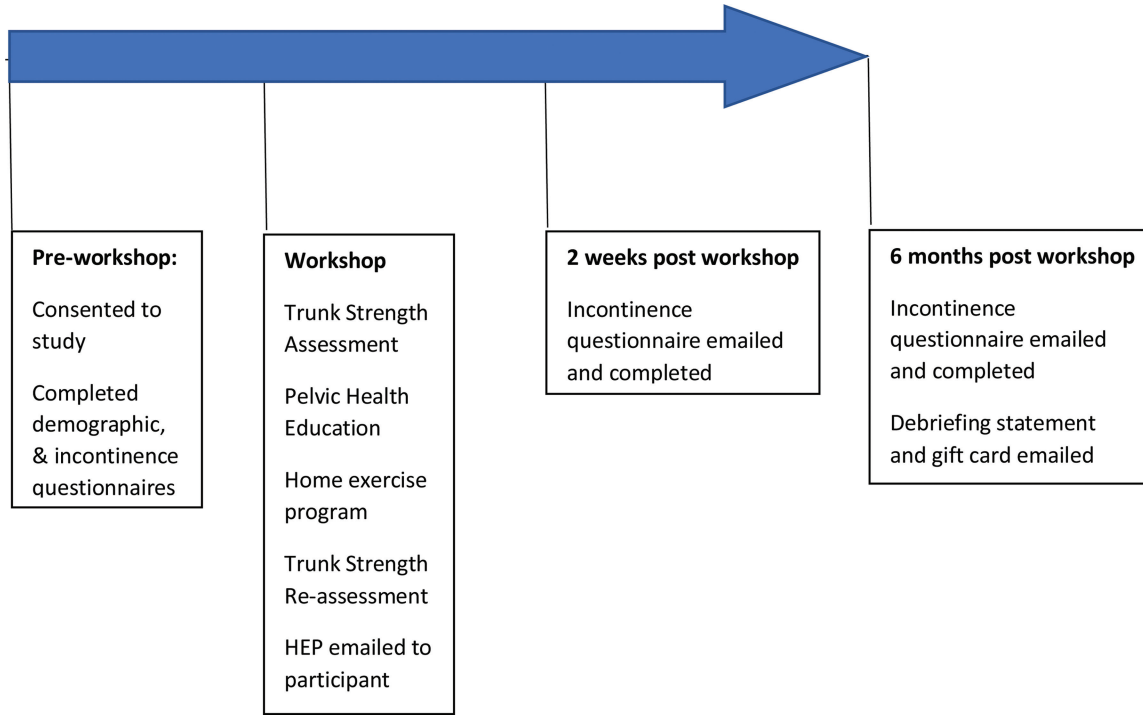

Figure 1. Time table of study procedures. HEP indicates home exercise program.

Figure 2. Trunk assessment utilizing CoreFirst® strategy.

Table 1. General Home Exercise Program[a]

In hookly:	
Breath work with hands on belly	1 set of 5-10 repetitions
PFM engagement with TVA on exhale	1 set of 5 repetitions with 5-s hold
Happy baby pose	1 set of 3 repetitions with 30-s hold
In sidely:	
Breath work with hand on belly and PFM and TVA engagement	1 set of 5 repetitions with 5-s hold
Clamshells with PFM and TVA engagement	3 sets of 10 repetitions
In quadruped:	
Breath work with PFM and TVA engagement	1 set of 3 repetitions with 5-s hold
In hookly:	
2-leg bridge with PFM and TVA engagement	3 sets of 10 repetitions with 5-s hold
In standing:	
Hip hinge squats	3 sets of 10 repetitions
Single-leg quarter squat	3 sets of 10 repetitions
Trunk assessment exercise	1 set of 6 repetitions

Abbreviations: PFM, Pelvic floor muscle; TVA, transversus abdominis.
[a]Each exercise was recommended to perform 4× per week, 1 time per day, and then 1-2× per week once incontinence resolved for appropriate maintenance through the 6-month time point.

pelvic health and a 75-minute exercise session. The educational session included time at the beginning to do the preintervention measure of trunk strength assessment. After the preintervention measure was taken, the PHPT provided education about the relationship of the diaphragm, pelvic floor, abdomen, intra-abdominal pressure, breathing, homunculus, and the relationship of the hip, back, and fascial connections within the body (see Figure 1).

During the exercise session of the workshop, the participants were given a handout of the general exercise program and were instructed in each exercise. The general exercises chosen for the workshop were based on the foundational knowledge of building awareness of the pelvic floor (PF) and transversus abdominis (TVA) muscles and coordination of these muscles with breath, followed by introducing extremity movement to facilitate the synergistic contraction of the PFMs[32–34] while coordinating breath and contraction of the PF and TVA muscles (see Table 1). The participants were encouraged to use their hands for self-cueing. Equal emphasis was placed on both the activation and the relaxation of the muscles as some women with SUI have been evidenced to have increased PFM and abdominal muscle activity with movement.[26] The participants were encouraged to use their breath and allow time for relaxation of their PFM before starting another repetition. The HEP was designed to be generalizable in nature and build awareness of the PFM and TVA muscles. To encourage adherence, the HEP focused on brief daily practice versus a high number of repetitions per day.

The PHPT demonstrated and instructed the participants in the exercises and provided key elements to focus on (eg, engagement of PFMs, abdominal muscles). Then the PHPT went to each participant and provided both verbal and tactile cueing to participants. The participants were also allowed to video with their mobile device any movements the PHPT instructed them in. The participants were able to ask questions at any time during the workshop. After the workshop, all participants were emailed their HEP.

During the exercise instruction, the participants were taught how to engage their PFM and TVA both in isolation and during dynamic movements such as side-lying thigh external rotation, bridges, and squats (Figure 3), as differentiated exercises have shown to be beneficial for incontinence.[35] The participants progressed from the floor to standing exercises, with a focus on incorporating appropriate breath patterns, pelvic floor, and abdominal engagement. The final exercise incorporated the automaticity seen during recruitment of muscles with single leg running gait stance (Figure 4). This exercise was adapted from the LPMT trunk assessment position and incorporated vertical hip plane motion (6× repetitions), knee

Figure 3. Integrated pelvic and orthopedic generalized home exercise program.

Figure 4. Final exercise: integrated pelvic and orthopedic exercise for home exercise program: single leg running stance with vertical plane hip motion, knee flexion and extension, and calf raise and lower.

flexion, and extension (1 repetition), while in a calf raise position (2 repetitions). The participants performed 1 set of 10 repetitions of each of the generalized HEP exercises on either side and more if they had time before moving to the next exercise being taught. The participants performed the final exercise 1 time on each side. After the workshop, the participants were given a debriefing statement and sent video links to the HEP.

Outcome Measures

After the 2-hour interventional workshop, Trunk strength reassessment scores were recorded. At the 2-week and 6-month follow-ups, the participants were emailed questionnaires to complete regarding their frequency and amount of leaking, overall strength, frequency of performing the HEP, and status of their orthopedic conditions and incontinence (see Figure 1).

Data Analyses

Mean, standard deviation, and percentages of the total cohort were calculated for relevant participant characteristics, including demographics, sleep quality, and sporting history.

Compliance to the HEP was assessed at the 2-week and 6-month time points using a 5-point Likert scale: never, 1 to 2×, 3 to 4×, 5 to 6×, and 7× per week. Right foot forward and left foot forward Overall Trunk Strength scores immediately before and after the interventional workshop were compared using a paired

samples *t* test. Participant-reported SUI outcomes of perceived magnitude of the problem and the amount of leakage were compared between time points using a McNemar-Bowker test. Frequencies of leakage across the various activities were extracted from the questionnaires and categorized as either "never" or "once or more" and compared across all 3 time points (baseline, 2 weeks, and 6 months) using a Cochran Q test with Bonferroni-corrected Dunn post hoc tests for pairwise comparisons. Alpha value was set at .05, and SPSS Statistics V27 (IBM, Armonk, New York) was used for all analyses.

RESULTS

Demographics

The participant characteristics of the cohort of 22 females are summarized in Table 2. The cohort mean and standard deviation of age and BMI were 44 ± 11 years and 22 ± 2 kg/m^2, respectively. Of the 19 women who were postpartum, 15 reported having vaginal deliveries and 4 by cesarean. Forty percent ran in high school and almost half of the runners had been running competitively for 10 or more years. Thirty-six percent reported history of a foot injury, about 31% each had a history of knee and ankle issues, and about 13% reported a history of shoulder and hip injury.

Compliance

At the 2-week follow-up, 86% of the participants were performing the HEP (n = 10: 1-2× per week; n = 7: 3-4× per week; n = 1: 5-6× per week; and n = 1: 7× per week) leaving only 3 participants who were not completing exercises. At the 6-month follow-up, 55% were performing the HEP (n = 9: 1-2× per week; n = 2: 3-4× per week; and n = 1: 5-6× per week).

Trunk Weakness and Overall Strength

Trunk weakness significantly and immediately improved after participating in the 2-hour workshop (Table 3) where participants' trunk strength was assessed at the beginning of the workshop (prior to exercise and HEP instruction) and assessed at the end of the workshop (after education and HEP instruction). The right side improved from a median interquartile range of 2.33 (1.00, 3.33) to 4.50 (3.33, 5.00) (P = .001) and the left side improved from 2.33 (1.00, 4.58) to 4.33 (3.33, 4.67) (P = .001), which was a difference of 2 stages in strength improvement within the 2-hour time frame (see Table 3). At 2-week follow-up, 12 participants reported improved overall strength, and 10 participants reported feeling the same in their overall strength. At 6-month follow-up, 12 participants again reported improved overall strength, 7 reported no change, and 3 reported worsened overall strength.

Table 2. Participant Characteristics[a]

	Participants (n = 22)
Age, y	44 (11)
Height, in	64 (3)
Weight, lb	128 (14)
BMI, kg/m^2	22 (2)
Pregnancy status	0 (0.0%)
Oral contraception status	1 (3.3%)
Hormonal replacement therapy status	0 (0.0%)
Child delivery history	
Vaginal	15 (68.2%)
Cesarean	4 (18.2%)
Menstrual cycle frequency	
Does not occur	7 (31.8%)
Rarely	0 (0.0%)
Every 2-3 mo	2 (9.1%)
Every month	13 (59.1%)
Competitive running in high school	9 (40.9%)
Running competitively, y	
<1	3 (13.6%)
1-5	3 (13.6%)
5-10	5 (22.7%)
10+	10 (45.5%)
Multisport status	
High school	19 (86.4%)
Current	12 (54.5%)
Injury history	
Hip	3 (13.6%)
Knee	7 (31.8%)
Ankle	7 (31.8%)
Foot	8 (36.4%)
Shoulder	3 (13.6%)

Abbreviation: BMI, body mass index.
[a]Data presented as mean (SD) or n (%).

Magnitude and Frequency of Incontinence

Self-reported magnitude of the problem and general amount of leakage were found to be the same between time points (Table 4). Significant improvements were seen in the frequency of leakages across time points (Table 5). Results are presented as the percent reporting any instance(s) of leakage (ie, a

Table 3. Trunk Strength[a]

Forward Side	Beginning of Workshop	End of Workshop	*P*
Right	2.33 (1.00, 3.33)	4.50 (3.33, 5.00)	.001
Left	2.33 (1.00, 4.58)	4.33 (3.33, 4.67)	.001

[a]Data are presented as median (interquartile range).

Table 4. Participant-Reported Incontinence Characteristics

	Baseline n (%)	Two-Week Follow Up		Six-Month Follow Up	
		n (%)	vs BL (*P*)	n (%)	vs BL (*P*)
Magnitude of problem			.112		.343
Not a problem	13 (59.1)	9 (40.9)		16 (72.7)	
A bit of a problem	6 (27.3)	12 (54.5)		6 (27.3)	
Quite a problem	2 (9.1)	1 (4.5)		0 (0.0)	
A serious problem	1 (4.5)	0 (0.0)		0 (0.0)	
Amount of leakage			.736		.255
None	9 (40.9)	9 (40.9)		9 (40.9)	
Dribble/pants wet	4 (18.2)	5 (22.7)		2 (9.1)	
Drops/pants damp	7 (31.8)	8 (36.4)		11 (50.0)	
Floods/soaks through	2 (9.1)	0 (0.0)		0 (0.0)	
Abbreviation: BL, baseline.					

decrease in percent is symptom improvement) categorized broadly as either "never" or "once or more." Improvements occurred after 2 weeks for jumping (41 to 5%, $P = .006$), landing from jumping (46 to 9%, $P = .003$), coughing (64 to 14%, $P = .001$), sneezing (59 to 14%, $P < .001$), and walking to bathroom (59 to 32%, $P = .016$) as compared with baseline by Bonferroni-corrected Dunn post hoc tests. Improvements occurred after 6 months for coughing (64 to 14%, $P = .001$) and sneezing (59 to 23%, $P = .006$) as compared with baseline by Bonferroni-corrected Dunn post hoc tests. No differences were found between the 2 follow-up time points. Figure 5 summarizes the frequency breakdowns for the 5 most relevant activities determined by these analyses.

DISCUSSION

This study found that female runners who reported having SUI significantly improved in their frequency of occurrence during daily and sport activities, trunk strength, and overall strength from a onetime in-person community intervention with HEP specifically targeting pelvic health for runners. Significant improvement was seen within events that required quick changes and control in intra-abdominal pressure—"Jumping up," "Cough," "Sneeze"—suggesting that this intervention improves intra-abdominal pressure control for SUI. "Cough" and "Sneeze" improvement from baseline continued to be significant at the 6-month mark, suggesting a term benefit of the program on SUI. The intervention did not seem to influence changes for activities that required heavy lifting; though the questionnaire did not inquire more about specific types of lifts (eg, dead lift vs squat).

It is questioned "whether exercising women are more likely to adhere to PFM training."[5] Our intervention and HEP met all of the predicting factors that have been outlined for positive adherence to physical therapy HEP.[36] The female running participants came to the workshop with the intention to engage in the HEP, were self-motivated and demonstrated self-efficacy and previous adherence to exercise-related behaviors, and had social support with many running clubs participating as a group.[36] In our study, more than half of the participating women averaged doing their HEP 1 to 2×/wk, with a quarter of women performing the HEP even more frequently throughout the 6 months of follow-up. The high compliance, defined as at least 1 to 2×/wk once incontinence resolved for appropriate maintenance of the HEP through the 6-month time point, in continuing the HEP likely added to the significant improvements seen in continence, as adherence to rehabilitation plans has been shown to correlate to better outcomes and fewer treatment sessions[37] and improve continence and sexual function.[38,39]

This intervention was successful at applying the one-on-one patient-provider clinical approach and effectively expanding this to a community group setting for treating SUI by including reported incontinence frequency, assessment, providing a HEP, and education. The questionnaires and assessment gave insight into a participant's pelvic floor dysfunction[18,40,41]; capturing baseline information of each participant. These assessments provided a foundation in the group setting to expand upon with education, a general HEP, and then test for outcomes.

From our results, the CoreFirst® Strategy test that is used in the one-on-one patient-provider clinical setting, the LPMT, was successful at capturing trunk strength changes of the group. This is an important finding as time and efficiency are always a factor in collecting outcomes, especially in a community group setting. Having a group measure that can efficiently and effectively capture changes from an

Table 5. Leakage Experiences

Activity	Never		Once or More		*P*[a]
	n	%	n	%	
During competition or practice					.236
Baseline	8	36.4	14	63.6	
2 wk post	12	54.5	10	45.5	
6 mo post	11	50.0	11	50.0	
Jumping up					.006
Baseline	13	59.1	9	40.9	
2 wk post[b]	21	95.5	1	4.5	
6 mo post	19	86.4	3	13.6	
Coming down from jumping					.004
Baseline	12	54.5	10	45.5	
2 wk post[b]	20	90.9	2	9.1	
6 mo post	17	77.3	5	22.7	
Running					.045
Baseline	10	45.5	12	54.5	
2 wk post	15	68.2	7	31.8	
6 mo post	16	72.7	6	27.3	
Approaching finish line					.067
Baseline	15	68.2	7	31.8	
2 wk post	18	81.8	4	18.2	
6 mo post	21	95.5	1	4.5	
Coughing					<.001
Baseline	8	36.4	14	63.6	
2 wk post[b]	19	86.4	3	13.6	
6 mo post[b]	19	86.4	3	13.6	
Sneezing					<.001
Baseline	9	40.9	13	59.1	
2 wk post[b]	19	86.4	3	13.6	
6 mo post[b]	17	77.3	5	22.7	
Heavy lifting					.247
Baseline	18	81.8	4	18.2	
2 wk post	21	95.5	1	4.5	
6 mo post	20	90.9	2	9.1	
Walking to bathroom					.012
Baseline	9	40.9	13	59.1	
2 wk post[b]	15	68.2	7	31.8	
6 mo post	14	63.6	8	36.4	
Sleeping					.368
Baseline	21	95.5	1	4.5	
2 wk post[c]	21	95.5	0	0.0	
6 mo post	22	100.0	0	0.0	
Hearing running water					.105
Baseline	18	81.8	4	18.2	
2 wk post	21	95.5	1	4.5	
6 mo post	21	95.5	1	4.5	

(*continues*)

Table 5. Leakage Experiences (*Continued*)

Activity	Never		Once or More		*P*[a]
	n	%	n	%	
Playing other sports noncompetitively					.174
Baseline	19	86.4	3	13.6	
2 wk post	22	100.0	0	0.0	
6 mo post	20	90.9	2	9.1	

[a]Cochran Q test.
[b]Difference from baseline statistically significant by Dunn post hoc tests with Bonferroni correction.
[c]One nonrespondent.

intervention, in particular, the neuromuscular and strength changes, is like what clinicians see during one-on-one care: yet here applied to a larger community setting. In addition to being used successfully as a group assessment technique, the LPMT was also a successful treatment exercise from orthopedic to pelvic care for female runners. Using the floor and the wall, the LPMT running-specific exercise allowed for the appropriate resistance to be applied, facilitating the desired motor response of a smooth, coordinated, and optimal muscle contraction.[31] The irradiation principle—the overflow of excitation

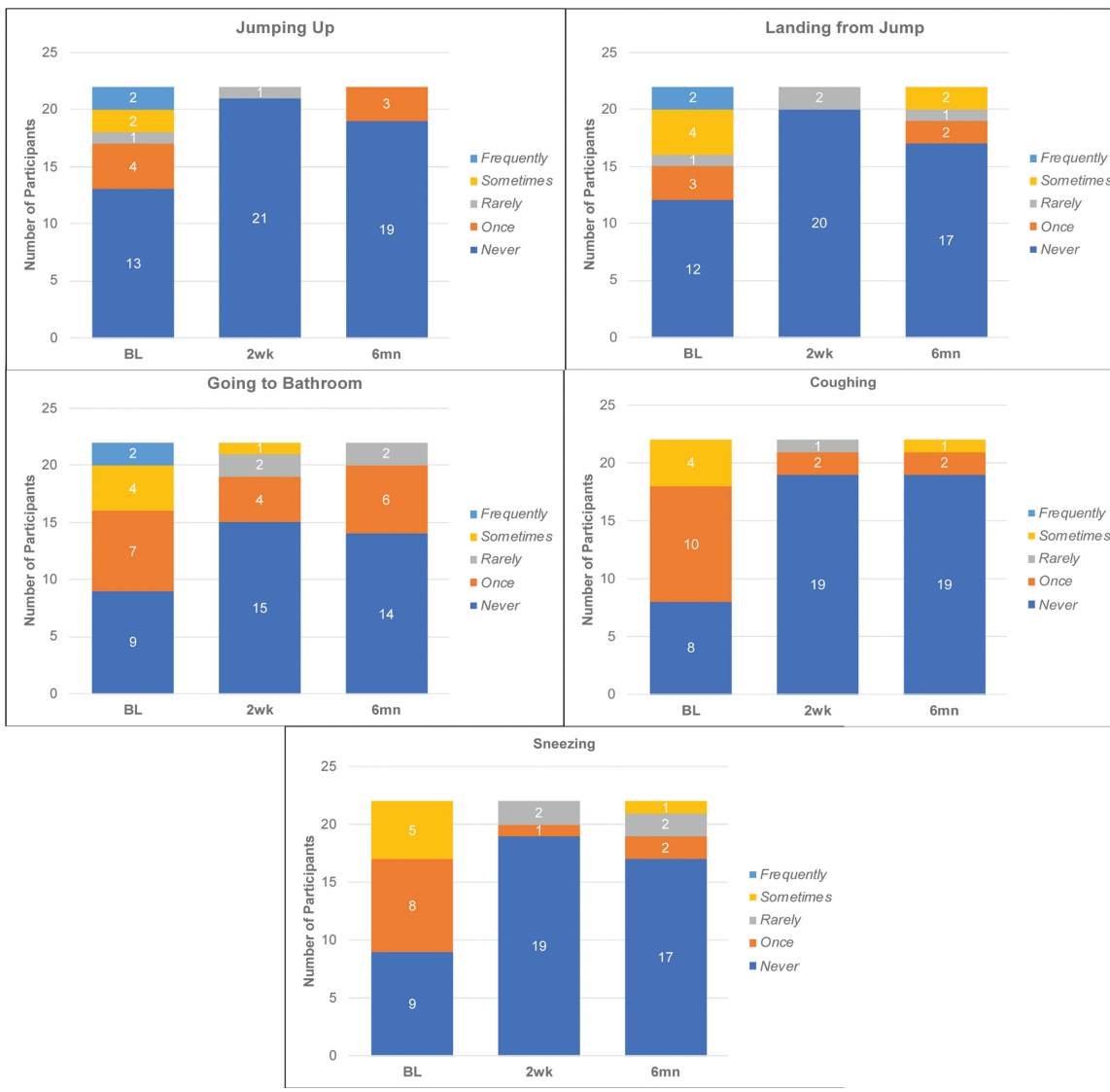

Figure 5. Breakdown of leakage experiences.

from stronger components to weaker or inhibited components—was used to produce an appropriate and enhanced contraction in weaker muscles.[31] In this case, the weaker muscles benefiting from the irradiation were the PFMs and those that contribute to their optimal performance such as the abdominals[34] and extremity[42,43] muscles. This connection of the extremity muscles to the pelvic floor and the irradiation principle enhancing any weaker muscles' engagement potentially explains why after only 2 hours of participating in the intervention there was a significant improvement in their LPMT postassessment. In addition, at 2-week follow-up, 50% of the participants reported feeling overall stronger, with these same individuals reporting still feeling "Better" in their overall strength at 6 months. The participants continuing to practice this irradiation technique possibly explains why their overall strength and incontinence continued to improve at the 6-month mark. This exercise united the individual components taught at the beginning of the exercise program and tied them dynamically together in the standing position, specific for running gait.

The quick 2-hour, 2-week, and long-lasting 6-month improvements reported in overall strength in combination with the significant improvements seen in the participants' SUI at the 2-week and 6-month time points are like what is seen clinically and can be related to the effectiveness of neuromuscular reeducation (NMRE). Neuromuscular reeducation, though not often well understood,[44] is a key component to PT treatment and shows to improve coordination, weight shift, and cocontraction of muscles,[44] producing more coordinated and fluid movement. This study provides preliminary data on the effectiveness of applying NMRE and its significant effect, within just a 2-hour window, and potentially assisting in the carryover seen at the 6-month time point. Although medications often have quick effects, and thus improve "by-in," compliance, and adherence from patients, physical therapy can employ NMRE because of its quick, effective, and efficient results in treating a patient's condition.

There is debate whether teaching PFM alone or in conjunction with abdominal[45–47] or extremity[48] muscles is better for SUI recovery. Other successful PFM treatment studies for SUI that have added abdominal and/or extremity muscles plus PFM training versus PFM training alone report more improvement in SUI outcomes,[43,45,47] while other studies report no difference between methods.[46,49] Our results support that a program including abdominal and extremity muscles with PFM engagement improves SUI[47] and reported overall strength. To further explore whether PFM alone or in conjunction with abdominal and extremity muscles improves SUI in female runners, it is recommended that a larger randomized controlled trial is conducted.

In addition to our study supporting that the inclusion of abdominal and extremity muscles with PFM training improves SUI, our study found that overall trunk strength improved within 2 hours, which was reportedly sustained throughout 6 months. Although not a reported outcome of the study, many participants wrote about the improvements they had in addition to their incontinence. For instance, the participants mentioned an improvement in their ability to participate in other recreational activities (eg, kickboxing), their running form, and improved sexual function. Our trunk strength finding supports that "other variables, such as muscular coordination and functionality, could benefit from the muscle synergy, producing better results in SUI treatment."[43] Although HEPs that include both PFM and extremity muscles may have the same outcome of PFM training alone,[46,49] they may actually have a quicker recovery in SUI than PFM training alone.[43] For instance, within the postpartum population, as the majority of our participants were, it has been found that there is a high "fear of movement" affecting their return to running[50,51] and that only 30% of highly active women return to their previous fitness level after 1 year postpartum and 75% return to previous fitness levels after 3 years postpartum.[52] Taking into account this study[52] looked at highly active service women, this is concerning when the general population, on average, are participating in lower activity levels.[53] Giving an appropriate program that is affordable, accessible, and effective at improving both overall strength and incontinence can potentially help the speed[43] of recovery and is worth investigating in future studies.

Clinicians need to expand their overall goals of care to include not just the isolated goal of improvement in incontinence but also the goals for improvements in overall strength, well-being, return to work/daily function, fitness, and performance. The implications of a community program that improves SUI, total body strength, and function have implications far beyond pelvic health, including long-term health, advocacy, and empowerment for women's lives.

Limitations

The primary limitation of the study is the lack of power analysis for sample size estimation. Although statistical and clinically significant improvements were observed, the results should be interpreted with caution due to a lack of prior sample size estimation. However, as a pilot feasibility study, these results provide valuable preliminary data to inform a power analysis for a future randomized controlled trial. Other limitations include lack of a comparative control group and lack of assessment of the potential

confounders of running habits and changes in running activity levels throughout the study after baseline assessment, which should be addressed in future studies. Other than the immediate overall trunk assessment, experiences of incontinence outcomes were assessed by subjective report using questionnaires. The participants could also have improvements in incontinence due to placebo effect because they believe that they are better in the questionnaire. In addition, recruitment was affected by the Covid-19 pandemic, halting all in-person workshops.

Future Directions

One future direction is to repeat this study with a larger sample size. Balancing a large group setting and collecting objective measures can be time intensive and would likely require in-person, small-group, or one-on-one appointments to collect such data, requiring more trained assessors and more time for the participants. Future studies could benefit from collecting outcomes of strength using objective measures such as dynamometers. In addition, for large population data collection, validation of a patient report of strength could be beneficial. To further understand whether this intervention can help female athletes participating in other sports who have incontinence, a questionnaire covering those specific activities is recommended.

Breath work plays an integral part in pelvic health coordination and dysfunction[18] as the diaphragm and pelvic floor are linked forming a "canister"[41] with piston-like caudal movement[54] that maintains intra-abdominal pressure[55] and continence.[56] Breath work, as given in this study's HEP, is a foundational exercise given for PHPT patients in the individual clinical setting. Further work is needed to establish the connection between reverse/paradoxical breathing patterns[54] and pelvic floor dysfunction and its positive implementation in a large group/community setting. The mechanism for improvement in incontinence observed in this study may be related to changing breath patterns and incorporating this change into ADL and sport through changes in motor control, as well as attention to breath and changing intra-abdominal pressure control.[19,57,58] This observation may be the focus of a future study.

CONCLUSIONS

Although the evidence is mixed as to whether and what kind of exercise helps/harms pelvic floor dysfunction in female athletes,[5,16] as strenuous work or exercise has also been widely debated as a possible risk factor, one thing is certain: there is a call for the development of protocols for the treatment of incontinence by PTs to improve the quality of life of women who practice elite sports.[16] There are currently no guidelines for HEPs for female runners with incontinence. Our understanding of the factors that cause SUI in the female athlete and designing HEPs to treat it have significantly broadened since 1998 when the overall treatment for SUI was to strengthen the PFMs.[59] With the evidence showing that SUI in the female athlete is a multifactorial issue,[27] it is time that our HEPs, as evidenced in this study's HEP, better reflect this. Simple handouts may never be the cure for SUI; however, paired with brief and educational workshops and emailed check-ins might be.

This study is the first of its kind to investigate whether a step-by-step clinical approach and applying it to a large community group format can create long-term prevention and resolve of reported incontinence. Our study sets a foundation to further investigate the effectiveness and efficiency of protocol-like programs for the treatment of incontinence in female runners.

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