Original Article

Pelvic Muscle Exercise Effect on Pelvic Muscle Performance in Women

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Abstract: The aim of this study was to compare pelvic muscle (PM) characteristics (strength, endurance and contractability) before and after 12 weeks of pelvic muscle exercises in two groups of older women: the first composed of women with genuine stress incontinence, and the second made up of women with no symptoms of urinary incontinence or pelvic organ prolapse. This research also investigated the extent to which PM pressure and health-related characteristics could help discriminate between women with and without a clinical sign of PM dysfunction. Within a framework of skeletal muscle fitness, outcome measures were defined and compared. There was no significant difference in the baseline \( (P = 0.09) \) and post-PME \( (P = 0.63) \) strength, endurance and contractability of the two groups of women. The two groups did differ significantly on change scores \( (P = 0.05) \) following PME. A greater improvement in strength for women without a clinical sign of dysfunction was demonstrated. There was a probability of 91% that those with a history of gynecological surgery belonged to the group of women with SUI.

Keywords: Pelvic muscle; Pelvic muscle exercise; Urinary incontinence

Introduction

The pelvic muscles (PM) are a skeletal muscle group important to urinary and fecal continence and to urological support. The functional demands on the PM include sustaining force over time, developing force quickly, and contracting and relaxing voluntarily. When these muscles do not function properly women may have a clinical sign of dysfunction, such as stress urinary incontinence (SUI), fecal incontinence (FI) and genital prolapse conditions. Reports of the prevalence of PM dysfunction are based on clinical signs of dysfunction and vary widely. Researchers estimate that the prevalence of urinary incontinence (UI) ranges from 10% to 58% in community-dwelling women [1], and increases with age [2] and parity [3,4]. Whereas UI has been associated with a history of gynecological surgery [5,6], hysterectomy in particular has been found to be associated with UI by some researchers [4] but not others [5]. Like the occurrence of UI in aging women, FI predominantly affects older women [1]. In general, women’s health problems related to PM dysfunction or poor muscle performance are believed to be widespread and underreported [1,7,8].

Evidence has been gathered that denervation of the pelvic muscles, accompanied by clinical muscle weakness, is an etiological factor in SUI, FI and genital prolapse [9–11]. PM denervation was associated with damage at the time of vaginal delivery [12]; parity [13]; a prolonged second stage of labor [12,13]; surgical dissection [14]; and gradual partial denervation with increasing age [15,16]. Histological analyses of PM biopsy samples [15] and PM single-fiber electromyographic studies [16] suggest that partial denervation is followed by subsequent reinnervation. Functional recovery of reinnervated skeletal muscle is rarely complete [17], and outstanding questions remain about the reversibility of denervation atrophy of skeletal muscle fibers in aging humans [18,19].

Pelvic muscle exercises (PME) based on landmark work by Kegel [20–23] strengthen the muscles and enhance voluntary control to promote normal function or improve performance. However, few studies have measured the effect of PME on PM performance in
women who do not have clinical signs of PM dysfunction. Dougherty and colleagues [24] reported increased strength measures following 12 weeks of PME in healthy women with a mean age of 52.5 years. In contrast, Thorp et al. [25] reported no treatment effect following a 6-week exercise protocol with younger nulliparous women whose mean age was 28.5 years.

Many researchers have reported on community-dwelling women with SUI, one clinical sign of PM dysfunction, who had completed PME protocols. Some investigations of PME protocols 6–24 weeks in length have reported an improvement in PM strength, and others have reported an increased ability to hold a contractions [26–32]. Wells [33] notes that many studies have reported on changes in urine loss variables, but not PM performance.

Boyington et al. [34] studied the PM response to PME in 10 women (mean age 51.7 years) who participated in a larger study of 65 women with SUI [32]. Graphic representations of voluntary PM contractions obtained before and after a 16-week PME program were analyzed according to pressure–time profiles. Four patterns of pressure–time profiles indicated that the PME regimen employed in the study did not produce a similar training effect in this sample. Thus, we know that PME is effective for decreasing mild to moderate SUI, but we know little about the varying PM responses to exercises in women with or without a clinical sign of dysfunction. In contrast, the literature is replete with examples of improved performance following the exercise of other skeletal muscles.

In the discipline of exercise physiology, skeletal muscle fitness includes the performance characteristics of muscular strength, muscular endurance and flexibility [35]. Strength and endurance relate to the occlusive and supportive functions of the PM. Muscular strength is the maximal force that can be generated by a specific muscle or muscle group [35,36]. Two indices recommended as outcomes of strength tests are the peak value and the average score. Muscular endurance is a performance characteristic of the ability of a muscle or muscle group to execute repeated contractions of a given force over time [35,37]. An endurance index can be determined by comparing subsequent contractions to an initial level of strength. Whereas flexibility does not apply to PM, the PM must adapt to different or changing requirements. Thus, the term contractability can be linked to the PM function demands of contracting and building force quickly. Adequate strength, endurance and contractability are important for the preservation of healthy PM functioning or fitness. Norm-referenced standards of strength, endurance and contractability are not available for the PM. However, outcomes based on a framework of muscular fitness provide an insight into characteristics indicative of functional capabilities, and contribute to an understanding of the effect of PME on PM (Table 1).

This study contributes to knowledge about PM and their response to PME in aging women by investigating performance characteristics that reflect the functional demands of this muscle group. A better understanding of the PM response to exercise will assist in prescribing exercise and monitoring the progress of women participating in exercise programs. Thus, the purpose of this study was to compare PM characteristics (strength, endurance and contractability) before and after 12 weeks of PME in two groups of older women: one composed of women with SUI and the other of women with no symptoms of UI or pelvic organ prolapse. Also, this research investigated PM performance and health-related characteristics predictive of clinical signs of PM dysfunction.

### Patients and Methods

This research was a secondary data analysis of PM pressures previously collected in two studies by Dougherty and colleagues [24,32] and stored as PM pressure–time data files on computer disk in Asystant+® (Macmillan, New York). The nurses who collected the measurements were not blinded to the pre- or post-exercise status, a limitation inherited by the secondary study. In study 1 [24], 85 healthy women between the ages of 35 and 78 years (M = 52.6; SD = 10.6) without clinical signs of PM dysfunction were recruited to complete a 12-week PME program. An improvement in maximum and sustained strength was reported. In study 2 [32], 65 women between 35 and 75 years (M = 51.3; SD = 10.6) with urodynamically demonstrated SUI completed a 16-week PME program and showed improved PM pressures.

The PME intervention was a graded three sessions per week exercise program that started with 15 repetitions and progressed to 45 repetitions. Group 1 increased the number of repetitions by 15 every 3 weeks, and group 2 increased repetitions by 15 every 4 weeks. Contractions were of maximal effort, with each 10-second contraction being followed by 15 seconds of rest. In both studies PM pressures were gathered in mmHg, using an intravaginal balloon device (IVBD) for which reliability and validity have been reported [38,39]. As recommended for assessments that require coordination and skill, women in both groups were familiarized with the measuring device. Those in study 2 had a waiting-list control visit 4 weeks after their baseline visit, when PME was initiated, and the control visit was used as baseline in the secondary study. In addition, data gathered at 12 weeks in the 16-week-long study 2 was used as the 12-week PME measure in this secondary analysis. In this

### Table 1. Pelvic muscle performance characteristics and variables

<table>
<thead>
<tr>
<th>Characteristic</th>
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<tbody>
<tr>
<td>Strength</td>
<td>Peak maximum pressure (PMP)</td>
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<td></td>
<td>Hold strength pressure (HSP)</td>
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<td>Endurance</td>
<td>Initial endurance index (IEI)</td>
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<tr>
<td></td>
<td>End endurance index (EEI)</td>
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<tr>
<td>Contractability</td>
<td>Rate of rise (RR)</td>
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