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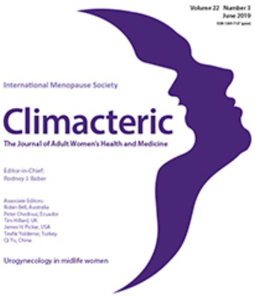

Keeping the pelvic floor healthy

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REVIEW

Keeping the pelvic floor healthy

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ABSTRACT

Female pelvic floor muscles form a diaphragm that spans the entire pelvic cavity. They consist of the fibers of the coccygeus and the levator ani muscles, the latter of which is composed of five parts. Together with their fascia, the pelvic floor muscles provide support for the urethra, the vagina, and the rectum and constrict the urethral, vaginal, and anal orifices. Alterations in the composition of the pelvic floor muscles at menopause appear to affect their properties and, thereby, their ability to function adequately. This can lead to an increased prevalence in urinary incontinence and other lower urinary tract dysfunction, pelvic organ prolapse, and genitourinary syndrome of menopause. This article aims to define the pelvic floor muscles and functions and to summarize the direct and indirect changes to women's pelvic floor muscles during and after menopause and through aging. A particular focus is also given to the evidence-based literature on how to keep pelvic floor muscles healthy during menopause and in postmenopause using conservative management therapy.

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Introduction

The female pelvic floor is a complex unit responsible for many functions beyond pelvic organ support[1]. It has the same embryonic origins as the vulva, the vagina, and the lower urinary tract[2]. All have estrogen receptors[2]; hence, the quality and proper functioning of these structures are, in part, dependent on the presence of estrogens. As menopause leads to decreased estrogen levels, 90% for estradiol and 70% for estrone[3], the resulting chronic hypoestrogenism also causes several changes in these structures. Thus, similar to the vulva, vagina, bladder, and urethra, the pelvic floor is also affected by menopause[4].

This article summarizes the literature on the female pelvic floor in postmenopause. The article:

- Defines the female pelvic floor, the pelvic floor muscles (PFMs), and their functions.
- Summarizes the direct and indirect changes to women's PFMs during and after menopause and through aging.
- Summarizes the evidence-based literature on how to keep PFMs healthy during meopause and in postmenopause.

The female pelvic floor, the pelvic floor muscles, and their functions

The female pelvic floor

The female pelvic floor is a complex functional unit comprising structures located within the bony pelvis: the urogenital and anorectal viscera, the PFMs and their connective tissues (the endopelvic fascia), nerves, and blood vessels[5].

The pelvic floor muscles

The PFMs form a diaphragm that spans the entire pelvic cavity and provide support for the pelvic organs[1]. They comprise the coccygeus and the levator ani muscles with their five parts: the pubovaginal, puboperineal, and puboanal portions, which form the pubovisceral complex, and the puborectalis and iliococcygeus muscles[6]. These parts of the levator ani muscle form three different regions of the pelvic floor, from anterior to posterior:

- The pubovisceral muscle consists of muscle fibers that arise from the pubic bone on either side of the symphysis and attach to the walls of the pelvic organs and the perineal body; these help to close the urogenital hiatus.
- The puborectal muscle forms a sling around and behind the rectum, just cephalad to the external anal sphincter.
- The iliococcygeal muscle forms a relatively flat, horizontal shelf spanning the potential gap from one pelvic sidewall to the other near the sacrum[6].

Functions of the pelvic floor muscles

PFMs have two major functions: they support or act as a 'closed floor' for the abdominal viscera, including the bladder, the uterus, and the rectum; and they provide a lifting and closing mechanism, or continence mechanism, for the

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urethral, vaginal, and anal orifices[1,6]. Healthy PFMs are symmetric and have a constant resting tone except just before and during voiding and defecation[5]. They can contract both voluntarily and involuntarily and can relax. During a PFM contraction, there is a constriction and inward (ventro-cephalad) movement of the pelvic openings. In response to increased intra-abdominal pressure, as experienced during a cough, healthy, well-functioning PFMs demonstrate controlled or limited perineal descent[5,7]. Overall, PFM functioning can be quantitatively defined by the muscle tone at rest (passive tone), the strength of the voluntary or reflex contractions, and the muscle's ability to relax after contracting[5,7].

Menopause and aging: direct and changes to women's pelvic floor muscles

Although menopause is considered a risk factor for PFM dysfunction, its effect on PFM function is not fully understood[8]. The difficulty encountered in separating the effects of menopause on PFMs from that of normal physiological muscle loss associated with aging also confounds research[9]. The following section presents the impact of menopause and aging on the PFMs and, using different objective measurement methodologies, summarizes observed changes in the PFMs.

Impact of menopause

The postmenopausal period is marked by a decrease in collagen in PFM connective tissues, which in turn reduces their elasticity or ability to recover their initial shape once force or pressure has been removed[10]. The effect of estrogen decline on the endopelvic fascia has not been studied[11]; however, it can be hypothesized that the collagen levels would also be affected, thereby decreasing the tissue's elasticity and rendering it more susceptible to strain.

Impact of aging

PFMs are skeletal muscles, and hence inclined to change with age[12]. Starting around the age of 40 years, there is an overall decrease in skeletal muscle mass and strength (sarcopenia)[12]. From 40 to 80 years of age, women continue to lose between 30 and 50% of their muscle mass[12]. This loss is both quantitative and qualitative: the number of 'fast-twitch' type II muscle fibers declines and fiber atrophy increases. Powerful but easily fatigued, type II muscle fibers function during intense but brief moments of exertion; such as trying to prevent leakage subsequent to a cough or a sneeze[13]. In contrast, 'slow-twitch' type I muscle fibers, or endurance muscles, are seemingly spared by aging; their numbers remain high with limited atrophy[13]. Aging is also associated with slower skeletal muscle contractile velocity, explained in part by the transformation of muscle fibers from type II (fast) to type I (slow)[13]. Age-related neuromuscular changes are characterized by a decrease in the number of motor neurons, as well as firing frequency[13]. For most women, neuromuscular changes to the PFMs could result in decreased overall muscle strength and power (the explosive aspect of strength calculated as the product of strength and speed of movement expressed as 'force × distance/time') and an increase in muscle fatigability[13]. Various techniques are used to identify changes in PFMs associated with menopause and aging: dynamometry, electromyography (EMG), manometry, ultrasound, and magnetic resonance imaging.

Dynamometry

Trowbridge et al.[14] studied PFMs' resting and maximal force using an intravaginal dynamometric speculum in a cohort of 82 nulliparous women aged 20–70 years. The resting vaginal closure force and augmentation of vaginal closure force did not change with increasing age, although older women exhibited a reduction in urethral closure pressure, as measured by urodynamic examination[14]. These controversial results can, however, be challenged because intravaginal dynamometric speculum measurements were taken at minimal aperture where very low force are produced and repeatability of measurement is weak[15].

A 2007 cohort study conducted by Morin et al. using dynamometry measured PFM resting forces and maximal voluntary contraction in continent and incontinent postmenopausal women. Age was negatively related to passive forces at different muscle lengths[16]. These results concur with a 2004 study by Gajdosik et al.[17], which found aging associated with a decrease in passive forces and increased stiffness in the large skeletal muscles. Morin et al.[18] also observed lower overall strength when comparing postmenopausal women to younger women. Interestingly, the older women in Morin et al.'s study[16] did not demonstrate reduced PFM peak strength alone, but rather a combined reduction in both passive + peak strength. This supports menopause and age both contributing to a decrease in passive muscle function. Urinary incontinence (UI) and/or pelvic organ prolapse (POP) symptoms could appear when the reduction in passive forces drops below a certain level and the urethral closure is no longer effective, both of which are side-effects of menopause and aging.

Electromyography

Gunnarsson et al.[19] assessed EMG activity during PFM voluntary contractions in women with stress, urgency, and mixed UI. They observed an age-related reduction in EMG amplitude regardless of UI type. In a similar study, in women with or without stress UI, Aukee et al.[20] observed a reduction in EMG activity associated with age in both, even in continent women. In 2018, Bocardi et al.[21] studied nulliparous continent women and found a negative correlation between age and electromyographic activity of the PFM. The results of the present studies on continent and incontinent aging women support lower EMG activity of the PFMs with greater age.

Morphometric ultrasonography

In a retrospective study of 375 patients, Weemhoff et al.[22] demonstrated a weak association between PFM contractility, morphometry of the pelvic hiatus, and age. Contractility was measured using vaginal digital palpation, and morphometry was analyzed using ultrasonography. The study found that as PFMs age, there is a reduction in muscular contractility and an increase in the diameter of the hiatus ($r = 0.21$, $p < 0.01$)[22]. This relationship remained significant even after controlling for the confounding effect of parity and levator defects.

Magnetic resonance imaging

Constantinou et al.[23] investigated how aging affects the movement of PFMs during voluntary maximum contractions. In the sagittal plane, the anterior movement of the PFMs was significantly lower in older women than in younger women. Similarly, in the axial plane, lateral compressions of the rectum and vagina during PFM contractions were also weaker in older women[23]. According to these imaging studies, aging may have an effect on contractility and distensibility of the PFMs.

Overall, the effects of menopause and aging on the PFMs are understudied. Only a few trials are available and some results are controversial. However, menopause and aging appear to be related to a reduction in PFM passive forces and in overall maximum voluntary contractions in most of the trials. Further, lower PFM EMG activity and larger levator hiatus appear to be related to greater age in women. As mentioned previously, the PFMs and fascia are essential components providing support for the urethra, the vagina, and the rectum and constrict the urethral, vaginal, and anal orifices. Alterations in their composition at menopause appears to affect their properties and, thereby, their ability to function adequately.

Menopause and aging: indirect modifications to pelvic floor muscles

Concurrent to menopause, external factors may also affect PFM dysfunction.

Weight gain

The risk of weight gain increases with menopause[24]. In addition to central adiposity, it has been hypothesized that the increased intra-abdominal pressure associated with weight gain may contribute to PFM dysfunctions[25]. Increased intra-abdominal pressure could increase bladder pressure, weakening the PFMs, which in turn could exacerbate stress and, possibly, urgency UI as well as promote POP[25]. Epidemiologic research has shown that increased body mass index is an independent risk factor for all types of UI and POP in women[26].

Other chronic health problems

Around the age of menopause, chronic coughing and constipation, as well as other health conditions, such as diabetes, become more prevalent. These may further impact the normal functioning of PFMs, either through a recurrent and sudden increase in intra-abdominal pressure (coughing and straining) or through neuropathy (diabetes)[27,28].

Pollakiuria, urinary urgency, and nocturia also increase in frequency during menopause[29]. A reduced bladder-sensory threshold can lead to an increase in bladder sensations, which cause more frequent urges to void. It also decreases the time interval between a first desire to void and an urgent need to void in patients with PFM dysfunctions[29]. The genitourinary syndrome of menopause (GSM) is known to be related to the loss of estrogen, resulting in vaginal dryness that could, in turn, cause discomfort and pain during intercourse[30]. Again, studies indicate a possible role for the PFMs[30] whereby the PFMs' increased tone and impaired voluntary relaxation secondary to the symptoms of GSM could lead to more friction between tissues during activities of daily living and sexual activity.

Maintaining healthy pelvic floor muscles: the evidence-based literature

Changes brought on by aging and menopause have a direct impact on PFM function. These changes also have an indirect impact on UI and other lower urinary tract symptoms, POP, and GSM. International clinical practice guidelines, such as the International Consultation on Incontinence, recommend conservative management for both prevention and first-line treatment for UI, related lower urinary tract symptoms, and POP[31]. Further, the promising results of a recent study support conservative management as an intervention for GSM[32,33]. This section discusses lifestyle modifications and PFM training (PFMT) for prevention and treatment of these conditions.

Conservative management

Conservative management is defined as any intervention not involving surgical or pharmacological approaches[5]. It is comprised of lifestyle modifications and PFMT[31]. Conservative management approaches are considered relatively low cost and non-invasive, with minimal adverse effects. They are typically guided by a health-care professional, the outcome of which is highly dependent on the level of user participation. It is generally accepted that conservative interventions should be part of initial management strategies at the primary-care level for individuals suffering from UI, lower urinary tract symptoms, or POP[31].

Lifestyle modifications

Lifestyle modifications refer to the application of interventions aimed at managing related health problems (e.g. switching to a healthy diet, regular participation in physical activities, and smoking cessation)[5]. The following lifestyle modifications may be applied to treat pelvic floor dysfunctions in perimenopausal or postmenopausal women, either in combination with other therapies or as 'stand-alone' treatments[31].

Weight management. Weight reduction may reduce pressure on the bladder and pelvic floor, thus reducing UI and POP. The PFMs support most of our body weight; hence, excess weight can strain and weaken these muscles. Weakened PFMs cannot adequately fulfill their support function for the bladder and bowel. It is recommended that women maintain their weight within a healthy range[31].

For urinary incontinence. Overweight and obese women are more likely to have UI as compared to women with a body mass index within a healthy weight range. Five randomized controlled trials and two meta-analyses show evidence to support weight-loss interventions to reduce UI in overweight or obese women[34,35]. A loss of 5% of initial body weight has an impact on the reduction of UI symptoms in obese women. Further, the odds of developing UI (at 1 year of the study) can be reduced by 3% for every kilogram lost by overweight and obese women[31]. Therefore, weight loss should be recommended to obese and overweight perimenopausal and menopausal women with UI, as a non-surgical intervention.

For pelvic organ prolapse. Overweight and obese women are more likely to have POP compared to women with a body mass index within a healthy weight range[36]. Weight loss is likely not associated with anatomic improvement, but may be associated with improvement in prolapse symptoms[31,37]. Although more research is needed, weight loss should be considered a primary option for obese women due to the beneficial effects on multiple organ systems and in reducing symptoms of pelvic floor dysfunction[31].

Constipation. The evidence from small, observational studies suggests that chronic straining may be a risk factor for the development of UI[31]. Further, two recent low-risk studies (which adjusted for covariates) concluded that constipation was associated with both prolapse symptoms and having prolapse surgery[31]. Although more research is needed to define the role of straining in the pathogenesis of both UI and POP, women should be encouraged to adopt good dietary habits (hydrate sufficiently, eat fibers) and good bowel movements habits (refrain from straining) in order to prevent constipation.

Risky workout regimen. There is no robust evidence for or against strenuous physical activity or high-impact sports and incontinence or POP[31]. Moreover, as physical activity is important for maintaining a normal weight and preventing diabetes, women should not be discouraged from exercising. However, given that menopause changes the PFMs, it is advisable to choose a sport or exercise that minimizes pressure on the pelvic floor[31]. There seems to be a higher prevalence of UI in those practicing high-impact sports like trampoline, volley ball, and running[38].

Pelvic floor muscle training

PFMT is defined as an exercise program aimed at increasing muscle strength, endurance, power, flexibility, and relaxation[5].

Prevention of urinary incontinence

One trial investigated the preventive effects of a multicomponent behavioral-modification program, compared to no intervention, in postmenopausal women. It involved 359 mostly continent women (0–5 days of incontinent episodes in the previous year). The intervention included PFMT, bladder training, and other behavioral modifications. Specifically, the intervention group attended a 2-h class, followed by an individualized session 2–4 weeks later to test their PFMT techniques and reinforce adherence. At 12 months, the intervention group was statistically and significantly better than the control group for continence status ($p = 0.01$), PFM strength (pressure score $p = 0.0003$; displacement score $p < 0.0001$), improved voiding frequency ($p < 0.0001$), and intervoid interval ($p < 0.0001$)[39]. Although more trials are needed, there is preliminary evidence supporting a multicomponent behavioral-modification program for postmenopausal women that includes PFMT for the prevention of UI.

Prevention of pelvic organ prolapse

One trial looked at the role of PFMT for the secondary prevention of POP in women around the age of menopause. The study involved 407 middle-aged women, 12 years after an index birth, who had POP-Q stage I, II, or III (55% with stage II or greater) and had not sought previous prolapse treatment (surgery, pessary, PFMT). Women were randomly assigned to an intervention or control group. The intervention group received one-to-one PFMT (five physiotherapy appointments over 16 weeks, and an annual review) plus Pilates-based PFMT classes and a DVD for home use. The control group received a lifestyle advice leaflet on POP. There was a significant benefit from PFMT in terms of fewer prolapse symptoms after 2 years, less UI, less interference due to symptoms of bowel problems, and less uptake of other treatments (surgery or pessary)[40]. Further, adverse events were minimal. Although more trials are needed to confirm these results, PFMT appears to prevent symptoms of prolapse, which develop in the longer term after childbirth.

Together, these results are important to clinicians and women generally; they help inform decisions about preventive strategies for UI and prolapse for women around the age of menopause.

Treatment for urinary incontinence

A recent Cochrane review studied the effect of PFMT on women with stress, urgency, or mixed UI across 31 trials that included a total of 1817 women from 14 countries. Women with stress UI in the PFMT group were, on average, eight times more likely to report being cured. Women with any type of UI in the PFMT group were, on average, five times more likely to report being cured. For women with stress and all types of UI, their incontinence symptoms and quality of life were improved in the PFMT groups. Women in the PFMT group were more satisfied with treatment, while those in the control groups were more likely to seek further treatment. Negative side-effects for the PFMT were rare and, in the two trials that reported them, the side-effects were minor. More importantly, benefits were shown across all age cohorts and UI types, as assessed by multiple outcome measures. PFMT is effective as a standalone therapy, but also as part of multicomponent therapies that include behavioral modification strategies such as bladder training and lifestyle interventions[41].

Treatment of pelvic organ prolapse

At the time of the last International Consultation on Incontinence (2017), there were 13 trials investigating the effect of PFMT for prolapse in middle-aged women. Most evidence demonstrates that PFMT significantly reduces pelvic floor symptoms in women with stage I–III prolapse, versus a control group. Among the studies, evidence was less consistent concerning the effectiveness of PFMT for the following specific symptom: a vaginal bulge or 'something coming down' associated with prolapse[31]. Overall, the present findings support the inclusion of PFMT in first-line conservative management programs for women with UI and POP; therefore, PFMT should be recommended to perimenopausal women with these problems[31].

Treatment of genitourinary syndrome of menopause

Although PFMT has only recently been proposed as a potential treatment for GSM, only one cohort study supporting PFMT as a potentially effective treatment was identified[32].

This cohort study included 32 postmenopausal women with GSM, aged 55 years and older (mean age of 68.0 ± 6.6 years and mean parity of 1.8 ± 1.1), diagnosed with GSM by a gynecologist. After ensuring correct performance of PFM contractions, women participated in a 12-week PFMT program that included a weekly 1-h session with a physiotherapist and daily home-based progressive PFM exercises. Post PFMT, improvement was found in the severity of the most bothersome symptoms of GSM. On physical assessment, vaginal secretions, vaginal epithelial thickness, and vaginal color were improved, PFM passive tone was reduced, and relaxation capacity was improved. Further, there was a reduction in impact of GSM on activities of daily living, quality of life, and sexual function. Although a randomized controlled trial is needed to confirm these results, preliminary data support the uptake of PFMT to alleviate GSM signs and symptoms while normalizing PFM function[32,33].

Conclusion

Menopause and aging affect PFMs both directly and indirectly. Increases in PFM dysfunction can lead to increased prevalence in UI, POP, and GSM. Conservative management around the age of menopause is effective in reducing PFM dysfunction and, therefore, an effective treatment to prevent or treat UI, POP, and GSM. As menopause is a time of change for women, clinicians involved with women's health should inform their patients about changes to the PFMs and encourage them to keep their PFMs active and healthy.

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