GYNECOLOGY

Physical activity and the pelvic floor

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Pelvic floor disorders are common, with 1 in 4 US women reporting moderate to severe symptoms of urinary incontinence, pelvic organ prolapse, or fecal incontinence. Given the high societal burden of these disorders, identifying potentially modifiable risk factors is crucial. Physical activity is one such potentially modifiable risk factor; the large number of girls and women participating in sport and strenuous training regimens increases the need to understand associated risks and benefits of these exposures. The aim of this review was to summarize studies reporting the association between physical activity and pelvic floor disorders. Most studies are cross-sectional and most include small numbers of participants. The primary findings of this review include that urinary incontinence during exercise is common and is more prevalent in women during high-impact sports. Mild to moderate physical activity, such as brisk walking, decreases both the odds of having and the risk of developing urinary incontinence. In older women, mild to moderate activity also decreases the odds of having fecal incontinence; however, young women participating in high-intensity activity are more likely to report anal incontinence than less active women. Scant data suggest that in middle-aged women, lifetime physical activity increases the odds of stress urinary incontinence slightly and does not increase the odds of pelvic organ prolapse. Women undergoing surgery for pelvic organ prolapse are more likely to report a history of heavy work than controls; however, women recruited from the community with pelvic organ prolapse on examination report similar lifetime levels of strenuous activity as women without this examination finding. Data are insufficient to determine whether strenuous activity while young predisposes to pelvic floor disorders later in life. The existing literature suggests that most physical activity does not harm the pelvic floor and does provide numerous health benefits for women. However, future research is needed to fill the many gaps in our knowledge. Prospective studies are needed in all populations, including potentially vulnerable women, such as those with high genetic risk, levator ani muscle injury, or asymptomatic pelvic organ prolapse, and on women during potentially vulnerable life periods, such as the early postpartum or postoperative periods.

Key words: exercise, pelvic floor disorder, pelvic organ prolapse, physical activity, sports, urinary incontinence

The burden of pelvic floor disorders

Pelvic floor disorders (PFDs) are common, with 1 in 4 US women reporting moderate to severe symptoms of urinary incontinence, pelvic organ prolapse, or fecal incontinence.[1] The estimated lifetime risk of surgery for either stress urinary incontinence (SUI) or pelvic organ prolapse (POP) is 20% by age 80 years.[2] Due to an increasing life span, the number of women who undergo POP surgery is estimated to increase by 47% from 2010 to 2050.[3] Given the high societal burden of these disorders, identifying potentially modifiable risk factors is crucial.

Physical activity (PA) is one such potentially modifiable risk factor. From a public health standpoint, understanding the relationship between physical activity and PFDs is important: given the magnitude of the burden suffered by women with PFDs, even a small reduction in risk would have an impact on a large number of women. As pointed out by DeLancey,[4] reaching a goal of 25% prevention would save <90,000 women each year from experiencing pelvic floor dysfunction. In this review, we summarize what is known about the association between physical activity and PFDs.

Data sources

The vast preponderance of research in these areas is cross-sectional and generally not population based. Ideally, a randomized clinical trial is obviously the best study design to understand the effect of PA done over a lifetime on PFDs. This is not only infeasible, but also randomizing women when young to a lifetime of exercise, or not, is unethical, given the many benefits of PA. Currently most of the available data pertain to urinary incontinence. Much less is known about POP and very little about fecal incontinence (FI).

For this review, we conducted a literature search to identify articles published in English-language journals from 1980 to March 2015. Additionally, we included a translated abstract if it contained sufficient information to provide the needed information. We did not restrict reporting based on quality of publications; the vast majority reported

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on a small population of women from one site. We searched PubMed using the search terms of exercise or physical activity or sport or athlete or work or occupation and urinary incontinence (UI) or FI or anal incontinence or pelvic organ prolapse or pelvic floor disorder.

Overview of physical activity

Physical activity defines any movement increasing energy expenditure. Physical fitness relates to characteristics an individual has that allows her to do daily activities with relative ease yet have reserve capacity to do greater levels of physical work upon emergent need (President's Council on Physical Fitness and Sports). Physical fitness includes a host of measurable attributes such as muscular strength and endurance and aerobic capacity that are in part heritable, which helps explain why like levels of physical activity do not always equate to the same levels of fitness in similar groups.[5-7]

It is now well known that physical activity has many benefits.[8-12] Most of the research about physical activity in women focuses on recreational activity (also known as leisure activity), which tends to be increasing worldwide, especially through walking.[13] Women do accrue PA in other domains such as in the home, although this type of activity has been steadily decreasing likely because of the availability of labor-saving devices.[14] Recently sedentary activity has emerged as an independent construct separate from recreational activity; that is, the negative health effects of being sedentary most of the day cannot be overcome by brief spurts of vigorous exercise.[15,16]

Given that obesity is associated with pelvic floor disorders, in particular urinary incontinence, persistent physical activity over a lifetime, which is associated with a decreased rate of weight gain, may help to prevent UI from developing.[17,18]

But is all physical activity good all the time? We can easily look to sports injuries to know that this is not the case.[19] Some sports cause more injuries and some people are more prone to them. Since the passing of Title IX legislations, girls' participation in high school sports has increased from <300,000 in 1972 to >3 million in 2013.[20] Furthermore, a worldwide survey consisting of approximately 65% female respondents indicates that high-intensity interval training was the biggest trend in the fitness industry for 2014, despite warnings about its increased potential for inducing injury.[21] Participation in sport and high-intensity PA among women heightens the need for understanding whether various types of physical activity modify the risk for pelvic floor disorders.

Measuring physical activity and pelvic floor disorders

Physical activity is most often measured by questionnaire, although it can also be measured objectively by accelerometry. Questionnaires are prone to recall bias and require varying degrees of literacy yet have been used extensively in population surveillance of PA.[13,22] Accelerometers, worn at the waist or on the wrist, quantify amounts of PA by assessing body acceleration, which have been used to identify intensity levels, such as light, moderate, and vigorous, as well as amounts of sedentary time.[23] However, accelerometry is less able to distinguish mechanical loads associated with PA. For example, accelerometry would not distinguish a woman walking with a heavy backpack from a woman walking without an additional load.

In the literature identified, most studies measured PA by questionnaires. In some cases, responses to the questionnaires were converted into metabolic equivalent (MET) values. A MET reflects the metabolic cost of an activity, and when multiplied by a measure of the duration, such as minutes of an activity done per week, PA exposure can be expressed as MET minutes per week. With few exceptions, the occupation was assessed using categorical variables, ranging from dichotomous heavy work (yes/no) to 6 self-described categories: laborers/factory workers, housewives, professional/managerial, service, technical/sales/clerical, or other. Most studies summarized only current recreational activities, whereas a few included past recreational activities or current occupational categories; one included childcare, eldercare, and housework.

Urinary incontinence was generally defined by questionnaires, both validated and unvalidated, and less frequently by pad testing. Most defined UI as any leakage during the specified time frame, and some required a certain level of frequency, bother, or severity. Pelvic organ prolapse was defined in one of several ways: as a symptom of bulge, as a finding on examination, and as a condition that led to surgery.

Physical activity and urinary incontinence

Urinary incontinence during exercise is common. The Table summarizes the prevalence of UI in various populations of active women and in control groups, if included. As evidenced by this table, even young nulliparas frequently report exercise incontinence, and the prevalence is greater in activities that involve repetitive jumping and bouncing. Whereas most studies rely on a self-report of UI, 2 confirmed UI with pad tests, in which leakage volume was estimated by subtracting the weight of a perineal pad after exercise from its weight before exercise.[24,25] In 18 girls who reported leakage during trampoline jumping, the mean change in pad weight was 28 g during a jump session.[25]

It appears that not only type of exercise but also dose makes a difference in terms of UI. In a different study of nulliparous trampolinists, those at the upper tertile of training volume reported the greatest negative impact from UI.[26] In another study suggesting that dose of exercise matters, women who trained for competitive purposes and were in the highest quartile of time spent in organized exercise per week were 2.5-fold more likely to report UI than inactive women in the lowest quartile; there were no differences between recreational exercisers who fell in the second and third quartiles compared with the inactive women.[27] In addition to type and dose of exercise, preliminary evidence suggests that eating disorders may also increase the risk of UI in athletes.[28,29] The etiology of this finding is unclear and deserves further study.

TABLE
Prevalence of urinary incontinence in women participating in sports

Year	Population, n	Subjects with UI, %	Controls, n	Subjects with UI, %
2014, Da Roza et al[26]	Nulliparous female trampolinists	72.7% during practice	NA	
2014, Fernandes et al[24]	Amateur soccer players, 12–19 y	62.8% positive pad test	Girls doing no sports, 11–19 y	25.0% positive pad test
2014, Poświata et al[87]	Elite endurance athletes, cross-country skiers, and runners	45.5%	NA	
2014, Schettino et al[88]	Volleyball players	65.7%	NA	
2012, Fozzatti et al[89]	Nulliparous women 20–25 y who attend gyms	24.6%	Nulliparous women who do not attend gyms and do not do high-impact exercise	14.3%
2011, Vitton et al[69]	Sports >8 h/wk	33.0%	Sports ≤8 h/wk	18.0%
2011, Jacome et al[90]	Basketball and indoor soccer athletes	41.5%	NA	
2011, Bo et al[91]	All fitness instructors	26.3%	Subgroup of yoga or Pilates instructors	25.9%
2010, Simeone et al[92]	Casual athletes 18–56 y	30.0%	NA	
2009, Salvatore et al[93]	Member of noncompetitive sports organization	14.9%	NA	
2008, Araújo et al[94]	Long-distance runners	62.2%	NA	
2007, Carls[95]	Young adult athletes	25.0%	NA	
2006, Larsen et al[52]	Nulliparous US military academy students	19.0%	NA	
2006, Caylet et al[96]	Elite athletes 18–35 y	28.0%	Nonelite athletes 18–35 y	9.8%
2002, Eliasson et al[25]	Elite nulliparous trampolinists 12–22 y	80% (only during trampoline training)	NA	
2002, Thyssen et al[97]	Elite athletes and dancers	51.9%	NA	
2001, Bo et al[29]	Elite athletes 15–39 y	SUI, 41.0% UUI, 16.0%	Age-matched nonathletes	SUI, 39.0% UUI, 19.0%
1994, Nygaard et al[98]	University varsity athletes	28.0%	NA	

NA, not available; *UI*, urinary incontinence; *UUI*, urge urinary incontinence.

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The fact that women of all ages frequently experience minor leakage while exercising does not answer the question of whether physical activity is associated with an increased risk of more severe UI in day-to-day life. Indeed, the association may be in the opposite direction. Increased PA could, by increasing overall strength, regularly engaging pelvic floor musculature, and decreasing weight, decrease UI or POP. Consistent with this hypothesis, several studies have shown that current leisure activity is associated with a lower odds of SUI, whereas the lack of exercise increases these odds.[30-32] After adjusting for the confounders, habitual walking decreases the odds of SUI by approximately half in older women from various ethnic backgrounds.[33,34]

Mild to moderate PA also decreases the risk of developing UI. In a prospective 12 year analysis of women aged 37–54 years in the Nurses' Health Study, the risk of at least monthly UI decreased with increasing quintiles of moderate PA (adjusted relative risk [RR], 0.89, 0.80, and 0.99 comparing extreme quintiles).[35] Furthermore, in this population, lower PA levels were associated with a greater odds of persistent UI at follow-up.[36] In older Latino adults, the 1 year incidence of UI was lower (odds ratio, 0.69, 0.50, and 0.95) in those that improved their physical performance score.[37]

There are limited data investigating whether strenuous activity while young increases UI later in life. In 2 small studies, neither Norwegian athletes nor former US Olympians participating in high-impact sports had greater

prevalence rates of SUI later in life compared with controls.[38,39] In contrast, the odds of current UI in young women who, 5−10 years earlier, had been competitive trampolinists as teens increased about 3-fold with both duration and frequency.[40]

In a large cross-sectional study in which middle-aged women recalled PA during the teen years, those who reported very high levels of strenuous PA as teenagers (>7.5 hours per week) had an increased odds of reporting SUI in middle age; subsequent strenuous activity adjusted for teen strenuous activity was not associated with SUI.[32] The teen years may represent a particularly vulnerable time period, given the dramatic changes in hormones, muscle and bone structure, and weight. Given increased risk for connective tissue injury during adolescence in girls,[41] it is biologically plausible that high strenuous activity during this period may affect future pelvic floor function.

Physical activity includes not only PA done during recreation (such as sports and exercise) but also PA occurring during work, childcare, eldercare, housework, and yardwork. These nonrecreational types are particularly relevant to women. For example, by including only recreational PA as is commonly done, almost 26% of 440 women studied met the Centers for Disease Control and Prevention guidelines for sufficient activity. However, this proportion increased to nearly 74% when activity from all domains was included.[42]

Yet few studies have evaluated the association between nonrecreational PA and UI. Most studies evaluating links between occupation and PFDs assessed activity grossly (generally in 2−4 categories) and accounted only for recent work. In one large population-based cross-sectional study of Chinese women, there was no association between occupation and UI.[31] In contrast, in another population of Chinese women, manual labor increased the odds of UI 7-fold compared with no manual labor.[43] Similarly, among rural Thai women, laborers had more incontinence than other workers.[44]

In a cross-sectional study in which all types of activity (exercise, work, childcare, eldercare, housework, and yardwork) were queried over a lifetime, middle-aged women who reported substantially increased overall lifetime PA had a slightly increased odds of SUI.[32] Increased lifetime leisure decreased and lifetime strenuous PA appeared unrelated to SUI odds in these middle-aged women.

Impact of UI on exercise

In a cross-sectional study of US women, 28% of those who report UI find it to be at least a moderate barrier to exercise. Of the women with UI, 11.6% did not exercise because of UI, 11.3% exercised less, 12.4% changed the type of exercise, and 5% stopped exercising in a gym. For women with severe UI, about one third did not exercise or exercised less because of UI.[45] Women with overactive bladder are less likely to report moderate and vigorous physical activities or to satisfy the recommended PA levels compared with those with no or minimal symptoms of overactive bladder.[46]

Impact of incontinence on work

Incontinence also has an impact on work. In a cross-sectional study of 2326 employed US respondents, more than one third reported urine loss. Incontinence at work was most commonly managed by frequent bathroom breaks and wearing pads. Of women with severe symptoms, 88% reported at least some negative impact on concentration, self-confidence, ability to complete tasks without interruption, or performance of physical activities at work.[47]

Similarly, among women surveyed from 5 countries, responses to a work productivity measure were lower in those with overactive bladder symptoms.[48] Incontinent women employed by a large university center used various strategies to manage the UI at work, including limiting fluids, avoiding caffeinated beverages, using voiding schedules, and keeping extra clothing on hand.[49] Women reported that UI had an impact on their working life by interfering with sleep with resultant fatigue at work and by causing embarrassment, poor concentration, and emotional distress. Half of the public school teachers surveyed reported making a conscious effort to drink less while working to avoid needing to use the toilet.[50] Women who drank less had double the odds of a urinary tract infection. Even female advanced practice providers with a specialized knowledge about lower urinary tract anatomy and physiology engage in behaviors at work that may be detrimental to bladder health, such as delaying voiding when busy.[51]

Physical activity and pelvic organ prolapse

Of studies that examine exercise and POP, none support an association.[52-54] In a case-control study of women not seeking tertiary care for PFDs aged 39−65 years with no or mild urinary incontinence, there were no associations between the odds of POP and overall lifetime physical activity, lifetime leisure activity, or lifetime strenous activity.[55] In contrast, several studies report associations between occupational activity and POP; these studies are for the most part limited by not considering confounders, poorly defining occupational and activity histories, using nonstandardized POP outcomes, and excluding household activities, which represent a large portion of daily activitiy for many women.

Literature to date suggests that women undergoing surgery for POP are more likely to report a history of strenuous jobs than women without.[56-58] In a cross-sectional study of Norwegian women, after adjustment for sociodemographic and lifestyle factors, self-reported occupations involving lifting increased the odds of surgery for POP 1.40-fold (95% confidence interval, 0.98−2.01) compared with occupations involving sitting.[59]

Heavy work is also associated with POP based on examination (variably defined)[54,57,60]; indeed, in one study, compared with age-matched controls with stages 0 and I POP, those with stage II or greater POP were 9.6 times (95% confidence interval, 1.3−70.3) more likely to report heavy occupational work.[61] In >1000 women attending routine gynecological care, laborers/factory workers were more likely to

demonstrate POP beyond the hymen on examination than other job categories.[60] However, the effect on bulge symptoms is mixed.[53,57,62,63]

In a review of risk factors for POP in developing countries, heavy work and poor nutrition were associated with POP, variably defined.[64]

Research from participants in the military suggests that certain activities may be sufficiently strenuous as to harm the pelvic floor. Among women doing summer basic training, those who attended paratrooper training were significantly more likely to have stage II prolapse at the end of the summer (RR, 2.72 and 1.37 less than RR <5.40; $P = .003$) than those who did not.[65]

Consistent with anecdotal evidence, short bouts of exercise increase POP severity in women with POP. In a study of women planning surgery for POP, prolapse was evaluated using Pelvic Organ Prolapse Quantification System after a bout of prescribed activity and then again the next morning.[66] There was a significant increase in Pelvic Organ Prolapse Quantification System stage and worsening of anterior, apical, and posterior support after activity compared with the following morning.

There are scant data on whether strenuous activity when young increases the risk of POP later in life. In a cross-sectional study, middle-aged women that reported 21 h/wk or more of strenuous activity during the teenage years were more likely to demonstrate POP, defined as prolapse beyond the hymen, on examination.[55]

Physical activity and fecal incontinence

In a cross-sectional analysis of women aged 62–87 years enrolled in the Nurses' Health Study, lower PA was associated with an increased odds of FI, independent of body mass index and functional limitations.[67] Similarly, in an analysis of 20–85 year old individuals participating in the National Health and Nutrition Examination Study, those with a worse perceived severity of FI engaged in less moderate to vigorous PA, as measured by accelerometry.[68]

In contrast, in a cross-sectional analysis of younger women (aged 18–40 years), 14.8% of the women participating in sports >8 hours per week reported anal incontinence compared with 4.9% of less active women.[69] After adjustment, the more active group was 2.99 (1.29–6.87) times more likely to report anal incontinence. For 84% of the women, the anal incontinence was represented by a loss of flatus. Of note, this difference does not seem to be solely related to faster colonic transit time because another study found similar small bowel and colonic transit times in asymptomatic athletes vs athletes with lower gastrointestinal symptoms during exercise.[70]

PA during pregnancy and early postpartum and future PFDs

Scant literature suggests that PA during pregnancy may increase the risk of postpartum UI.[71,72] These studies, however, did not comment on the intensity of exercise, did not exclude women with prepregnancy UI, and did not note the amount or timing of PA related to pregnancy duration. One study found that in primiparous women, high-impact PA before pregnancy was associated with UI 1 year postpartum, whereas low-impact activity was not.[73]

Among women residing in a tribal village in India, UI was increased in those who resumed heavy work in the early postpartum period.[74] Similarly, an early return to work after childbirth increased the risk of stage II POP or greater in a small study of Nepalese women.[75]

Impact of treating PFDs on PA

In a prospective observational study, PA was assessed before and 6 months after midurethral sling for SUI.[76] The proportion meeting the criteria for sufficient leisure PA increased from 44% at baseline to 54% at follow-up, whereas the median leisure PA energy expenditure increased from 396 to 693 MET minutes per week. On a multiple logistic regression, improvements in both UI severity and effect were associated with improvements in physical functioning scores, partially attributed to increased PA. In contrast, in a study of 69 active Finnish women, successfully treating SUI did not change the activity pattern, as measured by accelerometry for 1 week before and after treatment.[77]

One year after sacrocolpopexy for advanced POP, 36% of the women increased, 18% decreased, and 47% did not change their preoperative exercise intensity level. Women were more likely to decrease (24%) than increase (11%) the frequency of major effort activities, like heavy lifting. Most (84%) reported that prolapse no longer interfered with activities.[78]

Pelvic floor structure and function in athletes

Little is known about how pelvic floor muscle structure or function differs in athletes. Assessed by magnetic resonance imaging, 10 nulliparous female high-impact frequent intense training athletes had about a 20% greater cross-sectional area and width of the levator ani muscles, compared with age-matched nulliparous nonathletic women.[79] Similarly, compared with 22 controls, 24 high-impact frequent intense training athletes showed a higher mean diameter of the pubovisceral muscle (0.96 cm vs 0.70 cm, $P < .01$), greater bladder neck descent, and a larger hiatal area on Valsalva maneuver on translabial ultrasound.[80] There were no significant differences in hiatal area at rest or on maximal voluntary contraction between the 2 groups. Counterintuitively, pelvic floor muscle strength, as assessed by perineometer, was less in a group of 30 athletes compared with 10 nonathletes.[81]

Future research

There is a substantial body of cross-sectional literature on urinary incontinence and exercise. However, far less is known about POP or FI and exercise. Few studies address the full spectrum of activity performed by girls and women, with few focusing on the trends in high school sport or high-intensity training participation.

Understanding how nutrition modifies the effect of heavy work on POP is important and will aid prevention efforts, particularly in underdeveloped countries. Prospective studies in all types

of populations are needed to begin to understand causality. Given how common both childbirth and surgery for pelvic floor disorders are, it is surprising how very few data are present about how the dose and timing of physical activity during these potentially vulnerable times have an impact on the pelvic floor and subsequent pelvic floor disorders.

It is also crucial to understand the role physical activity, a potentially modifiable risk factor, plays in women at potentially high genetic risk,[82] women with risk factors for levator ani muscle injury,[83] or, importantly, the substantial minority of women with asymptomatic POP.[84-86] ■

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