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PHYSICAL ACTIVITY AND THE PELVIC FLOOR

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Abstract

Pelvic floor disorders (PFDs) are common, with one in four U.S. 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 is to summarize studies reporting the association between physical activity and PFDs. Most studies are cross-sectional and most include small numbers of participants. The primary findings of this review include: 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 exam 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

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injury, or asymptomatic pelvic organ prolapse, and on women during potentially vulnerable life periods, such as the early postpartum or postoperative periods.

Keywords

urinary incontinence; pelvic organ prolapse; pelvic floor disorder; physical activity; exercise; sports

The burden of pelvic floor disorders

Pelvic floor disorders (PFDs) are common, with one in four U.S. 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 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 impact a large number of women. As pointed out by DeLancey, reaching a goal of 25% prevention would save over 90,000 women each year from experiencing pelvic floor dysfunction.[4] 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 of course the best study design to understand the effect of PA done over a lifetime on PFDs. This is not only infeasible, but randomizing women when young to a lifetime of exercise, or not, is also unethical given the many benefits of PA. Currently, most of the available data pertains 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 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” or “fecal incontinence” 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.[5,6,7]

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 due to 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 under 300,000 in 1972 to over 3 million in 2013. [20] Further, a worldwide survey consisting of ~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, though 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 additional load.

In the literature identified, most studies measured physical activity by questionnaires. In some cases, responses to the questionnaires were converted into MET values. A MET reflects the metabolic cost of an activity, and when multiplied by a measure of duration, such as minutes of an activity done per week, PA exposure can be expressed as MET-minutes per week. With few exceptions, occupation was assessed using categorical variables, ranging from dichotomous heavy work "yes/no" to six self-described categories: laborers/factory workers, housewives, professional/managerial, service, technical/sales/

clerical, other. Most studies summarized only current recreational activities, while 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. Table 1 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. While most studies rely on self-report of UI, two 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 that 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 that 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 2nd and 3rd quartiles compared to 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.

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 physical activity 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 lower odds of SUI while lack of exercise increases these odds.[30–32] After adjusting for confounders, habitual walking decreases the odds of SUI by roughly one-half in older women from various ethnic backgrounds. [33,34]

Mild to moderate physical activity also decreases the risk of developing UI. In a prospective 12-year analysis of women ages 37 to 54 years in the Nurses' Health Study, the risk of at least monthly UI decreased with increasing quintiles of moderate physical activity (adjusted RR 0.89, 0.80, 0.99 comparing extreme quintiles). [35] Further, in this population, lower physical activity levels were associated with greater odds of persistent UI at follow-up. [36] In older Latino adults, the 1-year incidence of UI was lower (OR 0.69, 0.50, 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 two small studies, neither Norwegian athletes nor former U.S. Olympians participating in high-impact sports had greater prevalence rates of SUI later in life compared to 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 that reported very high levels of strenuous PA as teenagers (more than 7.5 hours per week) had 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 that done during recreation (such as sports and exercise) but also that occurring during work, childcare, eldercare, housework and yardwork. These non-recreational 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 CDC 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 non-recreational 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 odds of UI 7 fold compared to no manual labor.[43] Similarly, amongst 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 that reported substantially increased overall lifetime PA had slightly increased odds of SUI.[32] Increased lifetime leisure decreased and lifetime strenuous PA appeared unrelated to SUI odds in these middle-age women.

Impact of UI on exercise

In a cross-sectional study of U.S. women, 28% of those that report UI find it to be at least a moderate barrier to exercise. Of 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 OAB are less likely to report moderate and vigorous physical activities or to satisfy the recommended PA levels compared to those with no or minimal symptoms of OAB.[46]

Impact of incontinence on work

Incontinence also impacts work. In a cross sectional study of 2326 employed U.S. respondents, over 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, amongst women surveyed from five 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 impacted their working life by interfering with sleep with resultant fatigue at work and by causing embarrassment, poor concentration and emotional distress. Half of public school teachers surveyed reported making a conscious effort to drink less while working, to avoid needing to use the toilet.[50] Women that drank less had double the odds of a urinary tract infection. Even female advanced practice providers with 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]

PA and POP

Of studies that examine exercise and POP, none support an association. [52,53,54] In a case-control study of women not seeking tertiary care for PFDs ages 39 to 65 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 non-standardized 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 occupation involving lifting increased odds of surgery for POP 1.40 fold (95% CI 0.98, 2.01) compared to occupations involving sitting.[59]

Heavy work is also associated with POP based on exam (variably defined)[54,57,60]; indeed in one study, compared to age-matched controls with stages 0 and I POP, those with ≥ stage II POP were 9.6 times (95% CI 1.3, 70.3) more likely to report heavy occupational work.[61] In over 1000 women attending routine gynecological care, laborers/factory workers were more likely to demonstrate POP beyond the hymen on exam 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. Amongst 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, 1.37<RR<5.40; p=0.003) than those that 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 POP-Q after a bout of prescribed activity and then again the next morning.[66] There was a significant increase in POPQ stage and worsening of anterior, apical and posterior support after activity compared to 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 hours/week or more of strenuous activity during the teenage years were more likely to demonstrate POP, defined as prolapse beyond the hymen, on examination. [55]

PA and FI

In a cross-sectional analysis of women ages 62–87 years enrolled in the Nurses' Health Study, lower PA was associated with increased odds of FI, independent of BMI and functional limitations.[67] Similarly, in an analysis of 20 t0 85 year old individuals participating in the National Health and Nutrition Examination Study, those with worse perceived severity of fecal incontinence engaged in less moderate-to-vigorous PA, as measured by accelerometry.[68]

In contrast, in a cross-sectional analysis of younger women (ages 18–40 years) 14.8% of women participating in sports > 8 hours per week reported anal incontinence compared to 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 AI. For 84%, the AI was represented by loss of flatus. Of note, this difference does not seem to be solely related to faster colonic transit time, as another study found similar small bowel and colonic transit times in asymptomatic athletes versus 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 urinary incontinence (UI).[71,72] These studies, however, did not comment on the intensity of exercise, did not exclude women with pre-pregnancy 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 one year postpartum, while low-impact activity was not. [73]

Amongst women residing in a tribal village in India, UI was increased in those that resumed heavy work in the early post-partum period.[74] Similarly, 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 criteria for sufficient leisure PA increased from 44% at baseline to 54% at follow-up, while the median leisure PA energy expenditure increased from 396 to 693 MET-minutes per week. On 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 one week before and after treatment.[77]

One year after sacrocolpopexy for advanced pelvic organ prolapse, 36% of women increased, 18% decreased and 47% did not change their pre-operative 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 MRI, 10 nulliparous female HIFIT (high impact frequent intense training) athletes had about a 20% greater cross-sectional area and width of the levator ani muscles, compared to age-matched nulliparous nonathletic women.[79] Similarly, compared to 22 controls, 24 HIFIT athletes showed a higher mean diameter of the pubovisceral muscle (0.96 cm vs. 0.70 cm, $P < 0.01$), 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 two groups. Counterintuitively, pelvic floor muscle strength as assessed by perineometer, was less in a group of 30 athletes compared to 10 non-athletes.[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 under-developed 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 little data are present about how the dose and timing of physical activity during these potentially vulnerable times impact 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 pelvic organ prolapse.[84–86]

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Table 1

Prevalence of urinary incontinence in women participating in sports

Year	Population (n)	% with UI	Controls (n)	% with UI
2014 Da Roza[26]	Nulliparous female trampolinists	72.7% during practice	NA	
2014 Fernandes[24]	Amateur soccer players, 12–19 years	62.8% positive pad test	Girls doing no sports, 11–19 years	25% positive pad test
2014 Poswiata[87]	Elite endurance athletes, cross-country skiers and runners	45.5%	NA	
2014 Schettino[88]	Volleyball players	65.7%	NA	
2012 Fozzatti[89]	Nulliparous women 20–25 years who attend gyms	24.6%	Nulliparous women who do not attend gyms and do not do high-impact exercise	14.3%
2011 Vitton[69]	Sports > 8 hrs/wk	33%	Sports ≤ 8 hrs/wk	18%
2011 Jacome[90]	Basketball and indoor soccer athletes	41.5%	NA	
2011 Bo[91]	All fitness instructors	26.3%	Subgroup of yoga or Plates instructors	25.9%
2010 Simeone[92]	Casual athletes 18 to 56 years	30%	NA	
2009 Salvatore [93]	Member of non-competitive sports organization	14.9%	NA	
2008 Araujo[94]	Long-distance runners	62.2%	NA	
2007 Carls[95]	Young adult athletes	25%	NA	
2006 Larsen[52]	Nulliparous U.S. Military Academy students	19%	NA	
2006 Caylet[96]	Elite athletes 18–35 years	28%	Non elite athletes 18–35 years	9.8%
2002 Eliasson[25]	Elite nulliparous trampolinists 12–22 years	80% (only during trampoline training)	NA	
2002 Thyssen[97]	Elite athletes and dancers	51.9%	NA	
2001 Bo[29]	Elite athletes 15–39	SUI: 41% UUI: 16%	Age-matched non-athletes	SUI: 39% UUI: 19%
1994 Nygaard[98]	University varsity athletes	28%	NA	