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# REGULAR EXERCISERS HAVE STRONGER PELVIC FLOOR MUSCLES THAN NON-REGULAR EXERCISERS AT MIDPREGNANCY

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Condensation: Exercising pregnant women had stronger pelvic floor muscles than inactive women, but pelvic floor muscle strength, not general exercise, was positively associated with continence.

Short version of title: General exercise and pelvic floor muscle strength

ABSTRACT

Background: Today, all healthy pregnant women are encouraged to be physically active throughout pregnancy, with recommendations to participate in at least 30 min of aerobic activity on most days of the week, in addition to perform strength training of the major muscle groups 2-3 days per week, and also pelvic floor muscle training. There is, however, an ongoing debate whether general physical activity enhances or declines pelvic floor muscle function.

Objectives: To compare vaginal resting pressure, pelvic floor muscle strength and endurance in regular exercisers (exercise $\geq$ 30 minutes $\geq$ 3 times per week) and non-exercisers at mid-pregnancy. Furthermore, to assess whether regular general exercise or pelvic floor muscle strength was associated with urinary incontinence.

Study design: This was a cross-sectional study at mean gestational week 20.9 (± 1.4) including 218 nulliparous pregnant women, mean age 28.6 years (range 19-40) and pre-pregnancy body mass index 23.9 kg/m$^2$ (SD 4.0). Vaginal resting pressure, pelvic floor muscle strength and pelvic floor muscle endurance were measured by a high precision pressure transducer connected to a vaginal balloon. International Consultation on Incontinence Questionnaire Urinary Incontinence Short Form was used to assess urinary incontinence. Differences between groups were analyzed using Independent Sample T-test. Linear regression analysis was conducted to adjust for pre-pregnancy body mass index, age, smoking during pregnancy and regular pelvic floor muscle training during pregnancy. P-value was set to $\leq$ 0.05.

Results: Regular exercisers had statistically significant stronger ( mean 6.4 cm $H_2O$ (95% CI: 1.7, 11.2)) and more enduring ( mean 39.9 cm $H_2O$sec (95% CI: 42.2, 75.7)) pelvic floor muscles. Only pelvic floor muscle strength remained statistically significant, when adjusting for possible confounders. Pelvic floor muscle strength and not regular general exercise was associated with urinary continence (adjusted B: -6.4 (95% CI: -11.5, -1.4)).

Conclusion: Regular exercisers at mid pregnancy have stronger pelvic floor muscles than their sedentary counterparts. However, pelvic floor muscle strength and not regular general exercise was associated with urinary incontinence. There is a need for additional studies in elite athletes and women performing more strenuous exercise regimens.

Key words: exercise, muscle strength, pelvic floor muscles, physical activity, pregnancy, urinary incontinence

# INTRODUCTION

Today, all healthy pregnant women are encouraged to be physically active throughout pregnancy, with recommendations to participate in at least 30 min of aerobic activity on most days of the week. In addition, they are recommended to perform strength training of the major muscle groups 2-3 days per week.[1] Moreover, women who have been sedentary prior to pregnancy, are now motivated to start engaging in regular physical activity and continue throughout pregnancy.[1] A Cochrane review has concluded that pelvic floor muscle (PFM) training during pregnancy has level 1A evidence to prevent and treat urinary incontinence.[2] Hence, all pregnant women are also recommended to do regular strength training of the PFM.

There is an ongoing debate whether general physical activity enhances or declines PFM function. Bø[3] described two opposing hypotheses on this possible relationship: 1. General physical activity strengthens the PFM by co-contraction of these muscles during increase in intra-abdominal pressure, and 2. General physical activity weakens the pelvic floor by imposing impacts on the pelvic floor that the muscles cannot counteract. To date, there is sparse knowledge on this relationship in the general female population, and we have not been able to find any such studies in pregnant women.[4]

The aim of the present study was to compare vaginal resting pressure (VRP), PFM strength and PFM endurance at mid-pregnancy in regular exercisers versus non-regular exercisers. Furthermore, to assess whether regular general exercise or PFM strength was associated with urinary incontinence (UI).

MATERIALS AND METHODS

This is a cross sectional study of 300 nulliparous pregnant women assessed at mean gestational week 20.9 (± 1.4) at Akershus University Hospital, Norway. The time period for inclusion was from January 2010 until April 2011.[5] Inclusion criteria were being in their first ongoing singleton pregnancy and being able to understand Scandinavian languages. Exclusion criteria were multiple pregnancy or previous miscarriage after gestational week 16. All women gave written informed consent to participate. The study was approved by the Regional Medical Ethics Committee (2009/170), and informed to the Data Protection Officer at Akershus University Hospital (2799026).

For the purpose of the present study, 218 women were included, divided into regular exercisers and non-exercisers. Data on exercise were collected through an electronic questionnaire at gestation week 21. The participants reported how often they performed the following exercises: brisk walking, running (jogging or orienteering), bicycling, training in fitness centers, swimming, aerobics (low and high impact), prenatal aerobic classes, dancing, cross-country skiing, ball games, horseback riding and other exercises. Regular exercisers were defined as women participating in general regular exercise training ≥ 30 min x ≥ 3 times per week. Women reporting that they never performed exercise were defined as non-exercisers. Data was obtained through an electronic questionnaire at mid-pregnancy.[5] The questionnaire had detailed questions on participation in exercise training. Questions covering pre-pregnancy exercise training were asked retrospectively in the same questionnaire (last three months before pregnancy).

Correct PFM contraction was defined as a squeeze around the pelvic openings and a lift of the perineum.[6,7] Two trained physical therapists taught the participants how to contract the PFM, and ability to perform correct contractions was verified by observation of inward perineal movement and vaginal palpation during attempt to contract.[7]

VRP, PFM strength expressed as maximal voluntary contraction (MVC) and PFM endurance (cm $H_2O$sec) were measured using a high precision pressure transducer connected to a vaginal balloon catheter (Camtech AS, Sandvika Norway). The method has demonstrated very good intra-observer reliability.[8,9] Only contractions with simultaneous visible inward movement of the catheter / perineum were considered correct.[7] Strength was estimated as the difference between MVC and resting pressure. Muscle endurance was assessed during attempt to hold the contraction for 10 seconds (cm $H_2O$sec), and quantified as the area under the measurement curve.[10] Three MVC followed by a short resting period and one holding period were performed. All measurements were done in crook lying position (flexed knees and hips with feet on the plinth).

The International Consultation on Incontinence Questionnaire Urinary Incontinence Short Form (ICIQ UI SF) was used to assess prevalence of UI.[11] ICIQ UI SF has been shown to have good construct validity, acceptable convergent validity and good reliability.[11] Women were classified to be continent when answering “never” to the question “How often do you leak urine?”

Statistical analysis

Background variables are presented as numbers and percentages (%) or means with standard deviations (SD). Results of the two groups are presented as means with standard deviations and differences as means with 95% confidence intervals (CI). Differences between groups are analyzed using Independent Sample T-test. Linear regression analysis was used to adjust findings for possible covariates. We adjusted for pre-pregnancy BMI, age, education, smoking during pregnancy and regular PFM training during pregnancy both for the analyzes of association between general exercise participation and PFM strength and PFM strength and UI. The selection of possible covariates was based on existing literature and clinical reasoning. P-value was set to $\leq 0.05$. There was no specific power calculation for this study.

RESULTS

Background variables for the study population is presented in Table 1. Ninty-six% of the study population were of Scandinavian origin. Regular exercisers were significantly older and a more women had a higher educational level than non-exercisers.

Table 2 shows VRP, PFM strength and PFM endurance in pregnant women reporting to be physically active ≥ 30 min ≥ three times per week at mean gestational week 20.9 (SD 1.4). All women who reported to exercise at mid-pregnancy, had been regular exercisers before pregnancy. There was no statistically significant difference between regular exercisers and non-exercisers in VRP. Pregnant women exercising regularly had stronger PFM and better PFM endurance than non-regular exercisers.

At the time of assessment, 16 women (17.3%) of the regular exercisers versus 30 (14.5%) of the non-exercisers reported to do PFMT ≥ 3 times per week (p=0.67). Table 2 shows the results of the linear regression analyses in which PFMT was one of the covariates adjusted for. The adjusted analyses showed that the difference in PFM strength was still statistically significant in favor of women exercising regularly whereas the adjusted analyses for VRP and PFM endurance were attenuated.

There was no difference between exercises and non-exercisers in prevalence of UI; at mid pregnancy 29 (31.2%) of exercisers and 48 (38.4%) of non-exercisers reported UI respectively (p=0.34). Adjusted linear regression analyses exploring the association between UI and VRP, PFM strength and PFM endurance found that only PFM strength was significantly associated with UI. This was an inverse negative association: adjusted B: -6.4 (95% CI: -11.5, -1.4).

## COMMENT

As far as we have ascertained this is the first study investigating the association between regular exercise and PFM variables during pregnancy. Our results showed that women exercising ≥ 30 minutes ≥ 3 times per week in mid-pregnancy had stronger PFM, also when adjusted for possible covariates. Further, PFM strength, not general exercise, was associated with continence.

When exploring the association between exercise and PFM variables during pregnancy one would expect PFM training to be the most important one, as this would indicate that it was the specific training of the PFM and not participation in general exercise counting for the association. Our results indicate that exercising ≥ 30 minutes ≥ 3 times per week may have a positive effect on PFM strength supporting hypothesis one put forward by Bø.[3] Ahead of this study there was, according to our knowledge, a paucity in research evaluating the effect of general physical activity on vaginal resting pressure/PFM tone, PFM strength and PFM endurance. Search on PubMed revealed only one study comparing PFM strength in exercisers and non-exercisers. Borin et al[12] compared 10 volleyball, 10 handball and 10 basketball players with 10 non-exercising controls and found that the athletes had weaker PFM than non-athletes. Our results are contradictory to these findings and indicate that women exercising during pregnancy have stronger PFM and better muscular endurance than their sedentary counterparts. However, the two studies differ in the type of population studied, number of participants and equipment used to measure PFM strength. Hence, both results may be correct, and there is an urgent need for more research in this area. It may be that for most women moderate exercise, as in the present study, may be beneficial, whereas strenuous exercise may be harmful for those already at risk.[4] This needs further investigation.

Several RCTs have found that PFM training during pregnancy increases PFM strength and can prevent and reduce UI during pregnancy.[2,13] However, other observational studies have shown that physical activity during pregnancy may increase the risk of postpartum UI.[14,15] Furthermore, one study found that pre-pregnancy high impact, but not low impact activity was associated with UI one year postpartum.[16] Unfortunately, none of these studies measured PFM function. In a study of 41 non-pregnant Brazilian women, an association between aerobic capacity and PFM strength was found.[17] However, while it was reported that 92% of these women were physically active, the mean $VO_2$ max was only 13.7 (± 2) mL / $kg^{-1}$ / $min^{-1}$, which can be classified as an extreme low level. In comparison, the average $VO_2$ max in Norwegian females of the same age (30-39 years) and the same BMI (around 24 $kg/m^2$) is 37.6 (±7.5) mL /kg/min.[18] In a systematic review on EMG PFM activity during impact activities such as coughing, running on a treadmill, horseback riding and rapid arm movements, the authors found that non-pregnant women with SUI had delayed PFM activity,[19] They concluded that impact activities causing involuntary and reflex PFM activity needs further study. Bø[3] proposed in one of the hypotheses about how exercise may affect the PFM, that a feed-forward loop or co-contractions of the PFM during increase in intra-abdominal pressure may strengthen the PFM. Such a co-contraction may cause a training effect on the PFM. However, a sufficient strong and quick enough co-contraction to counteract the intra-abdominal pressure would only occur if the PFM have an optimal function. Weak or injured muscles may not be able to react in time or with sufficient strength to prevent leakage. Why PFM strength and not endurance was associated with general exercise may be explained by PFM strength being more related to the quick and strong response needed to resist rise in intra-abdominal pressure. This needs further investigations.

In the present study, general regular exercise training was not associated with a reduced prevalence of UI. This is in line with results of former studies showing a high prevalence of

UI in general exercisers[20]and in elite athletes.[3,4] However, some studies have reported different results.[14,21,22] Furthermore, we have previously reported that continent women have stronger PFM during pregnancy.[5] In the present study we provided adjusted analysis on this relationship, finding that this association was still statistically significant. Hence, we suggest that general and moderate, regular physical activity may increase PFM strength, but it is the PFM strength, and not the general exercises, that contribute to female continence during pregnancy. Based on this finding, we suggest encouraging more focused PFM education and training for young women.

There has been some concern that strong PFM during pregnancy may negatively affect labor and childbirth. However, a recent systematic review including 12 RCTs / quasi-RCTs involving 2243 primigravida women concluded that PFM training significantly shortened 1st (mean 28 min) and 2nd stage (mean 10 min) of labor. In addition, antenatal PFM training did not increase the risk of episiotomy, instrumental vaginal delivery and perineal laceration.[23] Moreover, a former publication from our group involving the same study group as the present study found that VRP, PFM strength and PFM endurance at mid-pregnancy did not negatively influence birth outcome.[24]

The strengths of the present study are the large number of participants, use of reliable and valid assessment methods and use of adjusted analyses to control for possible covariates. A limitation may be lack of power calculation and lower numbers of women exercising regularly compared to non- exercisers. Given the limited scientific evidence in this area, more studies are needed to elaborate on the relationship between general physical activity, including strenuous exercise and elite athletes, and PFM function.

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Table 1. Characteristics of the study participants. N= 281 nulliparous women at mean gestational week 20.9. Numbers with percentages, mean with range or standard deviation (SD).

| | Study sample (N= 218) | Regular exercisers (n=93) | Non- exercisers (n=125) | *P* value |
|---|---|---|---|---|
| Age (years) | 28.6 (range 19-40) | 29.9 (range 22-40) | 27.7 (range 19-38) | <0.001 |
| Pre-pregnancy BMI (kg/m$^2$) | 23.9 (SD 4.0) | 23.6 (SD 3.7) | 24.2 (SD 4.3) | 0.233 |
| Education level | | | | |
| - College or university | 159 (72.9 %) | 79 (84.9 %) | 80 (64.0 %) | 0.001 |
| - Primary school/high school/other | 59 (27.1 %) | 14 (15.1 %) | 45 (36.0 %) | |
| Marital status | | | | |
| - Married or cohabitant | 206 (94.5 %) | 89 (95.7 %) | 117 (93.6 %) | 0.502 |
| - Single | 12 (5.5 %) | 4 (4.3 %) | 8 (6.4 %) | |
| Smoking at gestational week 18-2 | | | | |
| - No | 205 (94.0 %) | 91 (97.8 %) | 114 (91.2 %) | 0.118 |
| - Sometimes | 5 (2.3 %) | 1 (1.1 %) | 4 (3.2 %) | |
| - Daily | 8 (3.7 %) | 1 (1.1 %) | 7 (5.6 %) | |
| Pelvic floor muscle training | | | | |
| - < 3 times per week | 185 (84.9 %) | 77 (82.8 %) | 108 (86.4 %) | 0.463 |
| - ≥ 3 times per week | 33 (15.1 %) | 16 (17.2 %) | 17 (13.6 %) | |
| UI midpregnancy | | | | |
| - No | 141 (64.7 %) | 64 (68.8 %) | 77 (61.6 %) | 0.270 |
| - Yes | 33 (35.3 %) | 29 (31.2 %) | 48 (38.4 %) | |

Table 2: Linear regression analyses with associations presented as unstandardized beta coefficients (B) with 95% confidence intervals and *P*-value [a]Adjusted for pre-pregnancy body mass index (BMI =kg/$m^2$), age, education, smoking during pregnancy, pelvic floor muscle training ≥ 3 times per week during pregnancy.

| Dependent variable | Exposure | Mean (SD) | Crude B (95% CI) | *P* value | Adjusted B (95% CI) | *P* value |
|---|---|---|---|---|---|---|
| Vaginal resting pressure (cm $H_2O$) | Exercisers (n=93) | 43.9 (9.8) | 0 | | | |
| | Non-exercisers (n=125) | 43.8 (10.2) | 0.03 (-2.68, 2.74) | 0.980 | 1,0 (-3.85 – 1.86) | 0.493 |
| Pelvic floor muscle strength (cm $H_2O$) | Exercisers (n=93) | 39.5 (18.3) | 0 | | | |
| | Non-exercisers (n=125) | 33.0 (17.2) | 6.4 (1.7, 11,2) | 0.008 | 5.6 (0.5 – 10.6) | 0.033 |
| Pelvic floor muscle endurance (cm $H_2O$sec) | Exercisers (n=93) | 270.8 (132.5) | 0 | | | |
| | Non-exercisers (n=125) | 230.9 (132.4) | 39.9 (4.2, 75.7) | 0.029 | 29.7 (-8.2 – 67.6) | 0.123 |