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Article

Impact of Parity and Delivery Type on Pelvic Floor Muscle Strength

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Abstract: Parity and vaginal delivery may contribute to the prevalence of female urinary incontinence. This study aimed to evaluate the impact of parity and the type of childbirth on pelvic floor muscle strength (PFMS). Materials and Methods: A total of 140 healthy women were prospectively evaluated and divided into four groups: G1 (n=34) aged 30-40 years; G2 (n=38) aged 41-50; G3 (n=35) aged 51-60; and G4 (n=33) over 60 years old. Demographic data and body mass index (BMI) were collected using a clinical questionnaire. Subjective PFMS assessments were conducted through trans-vaginal digital palpation (TDP), while objective evaluations were obtained using a portable perineometer. Results: BMI was significantly higher in G4 compared to G1, with a positive linear relationship observed between age and BMI. The number of pregnancies was higher in G4 compared to G2, and vaginal delivery was more frequent in G4 compared to G1 and G3. However, there was no statistical correlation among the different groups in PFMS as assessed by either TDP or perineometer. Additionally, no negative linear relationship was found between PFMS and parity or the number of vaginal deliveries. Conclusion: Our data indicate that neither the number of pregnancies nor the number of vaginal deliveries had an impact on PFMS in continent women.

Keywords: pregnancy; childbirth; type of delivery; pelvic floor muscle strength

1. Introduction

Urinary incontinence (UI) is highly prevalent after pregnancy, with several risk factors implicated in its pathophysiology, including multiparity, smoking, constipation, and coffee intake [1]. Some studies have linked UI to the type of delivery, identifying vaginal delivery and obesity as significant contributors [2]. Controlled trials have also shown that the number of pregnancies, parity, and vaginal delivery can lead to pelvic floor muscle (PFM) weakness [3,4].

Some authors suggest that women with urinary incontinence (UI) have weaker pelvic floor muscles (PFM) compared to those without UI, highlighting that PFM dysfunction could be a significant contributing factor to UI [5]. PFM disorders may arise after vaginal delivery, multiple pregnancies, or during the climacteric period. In these cases, neuromuscular injury or ischemia during complicated or prolonged labor can weaken pelvic floor support structures, with the clinical impact becoming more pronounced with the onset of menopause [3].

Additionally, studies on cadaveric donors have shown an age-related decrease in the number of levator ani muscle fibers [6]. Given these considerations, understanding the influence of the type of childbirth, the number of pregnancies, and the effects of the natural aging process on the pelvic floor muscle (PFM) strength of healthy, continent women is crucial. Currently, there is a lack of comprehensive knowledge in this area. Such information could be invaluable for more effectively addressing and treating PFM dysfunction post-delivery, and even for preventing voiding dysfunction and/or urinary incontinence in these women. This study aimed to evaluate the impact of parity and the type of childbirth on PFM strength in healthy, continent women.

2. Methods

A total of 140 healthy women were prospectively evaluated for this study. To be eligible, participants were required to have no urological complaints or clinical metabolic diseases. The volunteers were visitors or accompanying members of patients attending consultations at the hospital. They were approached in the waiting room, informed about the research, and, if they agreed to participate, were asked to sign an informed consent form. The study was approved by the Medical Research Ethics Committee (MREC) of our institution (MREC protocol number: 61/07). Participants were consecutively enrolled and divided into four groups (G) based on age: G1 (n=34) for ages 30-40 years; G2 (n=38) for ages 41-50 years; G3 (n=35) for ages 51-60 years; and G4 (n=33) for those over 60 years old. Demographic data, including age, body mass index (BMI), level of physical activity, and number and type of childbirths, were collected using a clinical questionnaire. Physical activity was defined according to Haskell et al., as engaging in moderate-intensity exercise for at least thirty minutes on five days per week [7]. BMI was calculated and classified according to World Health Organization guidelines. The degree of pelvic organ prolapse was assessed and graded based on the system proposed by Baden et al. [8].

A gynecological examination was conducted with the participant in stirrups, consistently performed by the same urologist. Subjective assessments of pelvic floor muscle strength (PFMS) were carried out using transvaginal digital palpation (TDP). The examiner assessed contractions in the posterior region of the vagina using the second and third fingers, which were fully extended and inserted into the vagina, while ensuring minimal discomfort to the participant. The women were instructed to contract their pelvic floor muscles against the examiner's fingers and maintain the contraction for as long as possible. Muscle strength was graded according to Amaro's 4-point scale: 0 = no contraction; 1 = mild muscle contraction, sustained for less than three seconds; 2 = moderate muscle contraction, sustained for less than five seconds; and 3 = normal muscle contraction, sustained for more than five seconds. This classification was tested but not validated [9]. Objective evaluation of pelvic floor muscle strength (PFMS) was conducted using a portable perineometer (Dynamed® model DM01, São Paulo, Brazil) with the participants in a bent-knee lying position. A balloon catheter, measuring 11x2.6 centimeters, was inserted into the vagina and inflated with 60 milliliters of air to ensure contact with the vaginal wall [5]. This volume was standardized across all participants. After calibrating the equipment, participants were asked to perform three pelvic floor muscle contractions, each held for as long as possible, with a 30-second rest interval between each contraction. Only contractions that produced a visible simultaneous inward movement of the perineum were considered valid. All assessments were performed by the same physiotherapist. The maximal peak of each contraction was recorded in centimeters of water (cm H2O), and the duration of each contraction was timed using a digital chronometer. To ensure accuracy, the mean value of the three measurements was used in the analysis.

Statistical Analysis

Over a 2-year study period, a sample of 140 women was proportionally distributed across four age groups, representing 24%, 27%, 25%, and 24% of the total sample, respectively. A confidence level of 95% with an estimated error margin of 10% was considered, with 65% of respondents agreeing to participate in the study. As a result, 140 participants were recruited. To compare the four study groups (Tables 1 and 2), a parametric analysis of variance (ANOVA) was used when the variable followed a normal distribution. When the variable did not adhere to a normal distribution, non-parametric analysis was applied. Parametric analyses were further examined using Tukey's multiple comparison test, while non-parametric analyses were followed by Dunn's test. For comparisons between only two groups, the parametric procedure employed was the Student's t-test for independent samples, and the Mann-Whitney test for non-parametric samples. All results were interpreted with a significance level set at 5%.

Table 1. Demographic characteristic in the different range age groups.

Variables	G1 (n = 34)	G2 (n = 38)	G3 (n = 35)	G4 (n = 33)	Statistical
Age ¹	35 (30.0;40.0)	45 (41.0;50.0)	54 (50.0;59.0)	60 (61.0;86.0) *	p< 0.001

Number of pregnancies ¹	3.0 (2.0;7.0)	3.0 (2.0;5.0)	3.0 (2.0;8.0)	4.0 (2.0;14.0) **	p=0.010
Vaginal deliveries ¹	0.5 (0.0;7.0)	1.0 (0.0;4.0)	0.5 (0.0;6.0)	2.0 (0.0;8.0) ***	p=0.005

¹ Median (minimum value; maximum value). * (p< 0.001) G4 X G3 X G2 X G1. ** (p< 0.05) G4 X G1. *** (p< 0.05) G4 X (G2, G3).

Table 2. Results of a subjective evaluation of PFM strength in the different groups.

Groups	1 (mild) n (%)	2 (moderate) n (%)	3 (normal) n (%)	Total
G1	11 (32.4) Aa	13 (38.2) Aa	10 (29.4) Aa	34
G2	12 (31.6) Aa	14 (36.8) Aa	12 (31.6) Aa	38
G3	9 (25.7) Aa	11 (31.4) Aa	15 (42.9) Aa	35
G4	8 (24.2) Aa	15 (45.5) Aa	10 (30.3) Aa	33

*Different upper-case letters indicate when groups were significantly different at the same evaluation moment (p<0.05). Different lower-case letters indicate when the moments were significantly different in the same group.

3. Results

BMI was significantly higher in G4 compared to G1 (27.9±3.6 versus 24.9±4.1, respectively; p=0.040). There was no statistical difference in BMI among other groups. The number of pregnancies was significantly higher in G4 compared to G2 (Table 1). The number of vaginal deliveries was significantly higher in G4 compared to G1 and G3 (Table 1). A positive linear relationship between age and BMI was found (r=0.215; p=0.011), demonstrating an increase in body weight with physiological ageing.

A significantly higher percentage of volunteers performed some level of regular activity in G4 compared to G1 (58% vs. 27%, respectively; p< 0.05). There was no statistical difference among the other groups. Regarding pelvic organ prolapse, despite a higher percentage of cystocele in group G4 (52%), in comparison to G1, G2 and G3 (32%, 45% and 34% respectively), there was no statistical difference among groups (p> 0.05). Rectocele was present in a higher proportion of women older than 50 years old (G3 and G4) in comparison to younger ones (G1 and G2), however with no significant difference among groups (33% and 34% vs. 18% and 19%, respectively, p > 0.05).

There was no significant difference among groups in the PFM strength assessment either by TDP and perineometer (Tables 2 and 3). We did not observe a negative linear relationship between PFM strength and the number of pregnancies (r=-0.70; p=0.409) or of vaginal deliveries (r=-0.026; p=0.758).

Table 3. Objective evaluation of PFM strength in the different groups.

Variables	G1	G2	G3	G4	“p” value
Maximum peak (cmH ₂ O) ¹	12.3 (7.0)	13.1 (7.3)	13.8 (5.5)	12.5 (5.0)	p = 0.744
Duration time (seconds) ¹	3.5 (1.8)	3.1 (1.3)	3.4 (1.6)	3.5 (1.8)	p = 0.643

¹ Mean (standard deviation).

4. Discussion

Pelvic floor disorders (PFDs) are prevalent among women as they age, impacting their overall health, self-image, and quality of life [10]. The prevalence of female PFDs, such as pelvic organ prolapse and urinary or fecal incontinence, is estimated at about 10%, with around half of women over 50 experiencing at least one of these conditions. These disorders often become more common with the onset of menopause [11]. Menopause also leads to other significant changes, including weight gain and alterations in fat distribution, which can increase the risk of menopausal symptoms and metabolic disorders.

Our study observed an increase in body weight with age among healthy women. Specifically, older women (Group G4) were found to be overweight compared to their younger counterparts. This weight gain may be attributed to menopause, possibly due to decreased levels of circulating estrogen [12]. A recent meta-analysis comparing pelvic floor function across different delivery methods found

that vaginal delivery might have a more significant negative impact on pelvic floor muscle (PFM) strength. However, the extent of this impact is still uncertain due to limitations such as varying study designs, inclusion and exclusion criteria, and methods of PFM assessment [13].

Further research is needed to better understand how the mode of delivery affects pelvic floor dynamics. Some experts suggest that routine post-delivery rehabilitation may be beneficial for improving PFM strength and elasticity [14]. In our study, older women (Group G4) had a significantly higher number of vaginal deliveries compared to younger women (Groups G1 and G3). Despite this, we did not find any statistically significant differences in PFM strength among the groups, whether assessed subjectively through palpation or objectively using a perineometer. Digital palpation, a quick and cost-effective method for quantifying PFM strength, has been criticized for its subjectivity [15]. However, research has demonstrated its good reliability and strong correlation with objective methods of PFM strength assessment [16–19].

While many researchers believe that pregnancy and childbirth contribute to a higher incidence of pelvic floor muscle disorders (PFMDs) [20,21], our study did not find a correlation between the number or mode of previous deliveries and PFM strength. This suggests that vaginal delivery may not necessarily decrease PFM strength in healthy, continent women. This finding is unexpected given that some studies indicate a correlation between vaginal delivery and PFM weakness, particularly in cases of female urinary incontinence [2,4]. However, it is crucial to recognize that urinary incontinence has a multifactorial pathophysiology, and prevention can involve addressing various factors such as PFM rehabilitation, hormonal replacement, and weight management.

Furthermore, while some data suggest that lifetime physical activity might slightly increase the odds of stress urinary incontinence, it does not appear to increase the risk of pelvic organ prolapse. According to Nygaard et al. [22], physical activity is a potentially modifiable risk factor for preventing pelvic floor muscle disorders. Interestingly, in our study, a higher percentage of elderly women (Group G4) engaged in physical activity compared to younger controls (Group G1). Despite this, we did not observe a higher incidence of prolapse in the physically active group. Current data are insufficient to determine if intense physical activity predisposes individuals to pelvic floor disorders later in life, but most studies suggest that physical activity benefits women's health without harming the pelvic floor.

5. Limitations

We did not categorize or classify the physical activity performed by participants. Therefore, we cannot definitively determine if increased physical activity among women correlated with stronger pelvic floor muscles (PFM). While our results cannot confirm this relationship, we hypothesize that the greater physical activity observed in older patients (G4) may have helped maintain PFM strength, despite these individuals having a higher number of pregnancies compared to G2 or more vaginal deliveries than G1 and G3. Additionally, the use of palpation and perineometers to assess PFM strength does not provide a comprehensive evaluation of the pelvic floor muscles.

6. Conclusion

Our data indicate that, despite the increase in BMI, number of pregnancies, and vaginal deliveries with age, these factors do not appear to negatively impact PFM strength in continent women. Future research could benefit from incorporating imaging techniques such as ultrasound or magnetic resonance imaging (MRI) to offer a more global assessment.

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References

1. Martins G, Soler ZA, Cordeiro JA, Amaro JL, Moore KN. Prevalence and risk factors for urinary incontinence in healthy pregnant Brazilian women. *Int Urogynecol J*. 2010;21(10):1271-1277.
2. Amaro JL, Macharelli CA, Yamamoto H, Kawano PR, Padovani CV, Agostinho AD. Prevalence and risk factors for urinary and fecal incontinence in Brazilian women. *Int Braz J Urol*. 2009;35(5):592-597.
3. Afshari P, Dabagh F, Iravani M, Abedi P. Comparison of pelvic floor muscle strength in nulliparous women and those with normal vaginal delivery and cesarean section. *Int Urogynecol J*. 2017;28(8):1171-1175.
4. Hwang JY, Kim BI, Song SH. Parity: a risk factor for decreased pelvic floor muscle strength and endurance in middle-aged women. *Int Urogynecol J*. 2019;30(6):933-938.
5. Yang XJ, Sun Y. Comparison of caesarean section and vaginal delivery for pelvic floor function of parturients: a meta-analysis. *Eur J Obstet Gynecol Reprod Biol*. 2019;235:42-48.
6. Cook MS, Bou-Malham L, Esparza MC, Alperin M. Age-related alterations in female obturator internus muscle. *Int Urogynecol J*. 2017;28:729-734.
7. Haskell WL, Lee IM, Pate RR, Powell KE, Blair SN, Franklin BA, et al. Physical activity and public health: updated recommendation for adults from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*. 2007;39(8):1423-1434.
8. Baden WF, Walker TA, Lindsey JH: The vaginal profile. *Tex Med*. 1968; 64:56-58.
9. Amaro JL, Oliveira Gameiro MO, Padovani CR. Treatment of urinary stress incontinence by intravaginal electrical stimulation and pelvic floor physiotherapy. *Int Urogynecol J Pelvic Floor Dysfunct*. 2003;14:204-208.
10. Jelovsek JE, Barber MD. Women seeking treatment for advanced pelvic organ prolapse have decreased body image and quality of life. *Am J Obstet Gynecol*. 2006;194(5):1455-1461.
11. Samuelsson EC, Victor FT, Tibblin G, Svärdsudd KF. Signs of genital prolapse in a Swedish population of women 20 to 59 years of age and possible related factors. *Am J Obstet Gynecol*. 1999;180(2 Pt 1):299-305.
12. Chopra S, Sharma KA, Ranjan P, Malhotra A, Vikram NK, Kumari A. Weight management module for perimenopausal women: A practical guide for gynecologists. *J Mid-life Health*. 2019;10:165-172.
13. Xiao-Jing Yang, Yun Sun. Comparison of caesarean section and vaginal delivery for pelvic floor function of parturients: a meta-analysis. *Eur J Obst Gynecol Reprod Biol*. 2019;235:42-48.
14. Genadry R. A urogynecologist's view of the pelvic floor effects of vaginal delivery/cesarean section for the urologist. *Curr Urol Rep*. 2006;7:376-383.
15. Zhao Y, Zou L, Xiao M, Tang W, Niu HY, Qiao FY. Effect of different delivery modes on the short-term strength of the pelvic floor muscle in Chinese primipara. *BMC Pregnancy Childbirth*. 2018;18(1):275.
16. Sartori DVB, Gameiro MO, Yamamoto HA, Kawano PR, Guerra R, Padovani CR, Amaro JL. Reliability of pelvic floor muscle strength assessment in healthy continent women. *BMC Urol*. 2015 Apr10;15:29.
17. Peng Y, Miller BD, Boone TB, Zhang Y. Modern theories of pelvic floor support: a topical review of modern studies on structural and functional pelvic floor support from medical imaging, computational modeling, and electromyographic perspectives. *Curr Urol Rep*. 2018;19(1):9.
18. Botelho S, Pereira LC, Marques J, Lanza AH, Amorim CF, Palma P, et al. Is there correlation between electromyography and digital palpation as means of measuring pelvic floor muscle contractility in nulliparous, pregnant, and postpartum women? *Neurourol Urodyn*. 2013 Jun;32(5):420-423.
19. Riesco ML, Caroci Ade S, de Oliveira SM, Lopes MH. Perineal muscle strength during pregnancy and postpartum: the correlation between perineometry and digital vaginal palpation. *Rev Lat Am Enfermagem*. 2010;18(6):1138-1144.
20. Yang S, Sang W, Feng J, Zhao H, Li X, Li P, et al. The effect of rehabilitation exercises combined with direct vagina low voltage low frequency electric stimulation on pelvic nerve electrophysiology and tissue function in primiparous women: a randomized controlled trial. *J Clin Nurs*. 2017;26(23- 24):4537-4547.
21. Shek KL, Dietz HP. Intrapartum risk factors for levator trauma. *BJOG*. 2010 Nov;117(12):1485-1492.
22. Nygaard IE, Shaw JM. Physical activity and the pelvic floor. *American Journal of Obstet and Gynecol*. 2016;214(2):164-171.

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