Effect of Antenatal Pelvic Floor Muscle Exercise on Mode of Delivery: A Randomized Controlled Trial

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Keywords
Pregnancy · Pelvic floor muscle · Exercise · Labor · Newborn

Abstract
Background: Vaginal delivery is the best end of the pregnancy for the mother and the newborn. Aim: To evaluate the impacts of short-term antenatal pelvic floor muscle (PFM) exercises on a woman’s mode of delivery. Methods: This is a randomized controlled trial that recruited 20 healthy pregnant women aged between 20 and 25 years and able to contract the PFM. The participants were included in the study at 20 weeks of gestation (WG) and were randomly allocated to one of two groups: the intervention group (n = 10) or the control group (n = 10). PFM strength was measured by vaginal squeeze pressure at 20 and 36 WG, and delivery outcomes were evaluated by a blinded searcher from the birth registry after labor. Results: There were no statistically significant changes between both groups at baseline regarding gestational age, type of labor, previous pregnancy complications, and PFM strength (p > 0.05). There was a significant change between both groups in mean PFM strength at 36 WG (p < 0.05). A significant correlation was observed between PFM strength at 36 WG and mode of delivery (vaginal delivery: r = 0.58, p < 0.05; caesarean delivery: r = −0.49, p < 0.05). Conclusions: PFM exercise is recommended for healthy pregnant women as a safe and inexpensive strategy for increasing the vaginal delivery rate.
both from the physical, psychological, and sociological point of view [3, 4]. It needs more physical and emotional preparation for pregnant women as the main target of the pregnancy for the future mothers, their families, and the health care system that supports them before and during labor [5].

Normal delivery is promoted all over the world because it offers low cost, shorter hospitalization after labor, lack of anesthetic requisites, a deceased infection rate, and less hemorrhage compared with cesarean section [1]. Vaginal delivery without episiotomy has many advantages, among them less perineal pain and earlier restarting of sexual intercourse [6]. Although most pregnancies will result in spontaneous vaginal delivery, under some circumstances, additional assistance is needed to deliver the infant. Operative delivery is any measure undertaken to facilitate labor [7].

All interventions of childbirth other than physiological should be used only when justifiable by the circumstances, such as obstructed labor, cord prolapse, or fetal distress [8–10]. These procedures may include instrumental deliveries with the use of vacuum or forceps as well as cesarean section. Their dimensions and effects may lead to changes in the quality of life of the women and their families [7, 11].

According to the WHO guidelines [8], cesarean sections are warranted only in 10–15% of births. These percentages are increased in contemporary civilization due to the phenomenon of known industrialized childbirth and cesarean sections on request, without medical grounds [3]. A cesarean section may result in several complications for both mother and newborn, such as hemorrhage [12], infection [13], increased mortality rate [14], premature birth [15], fetal respiratory distress [16, 17], postpartum depression, and decreases fertility rates [18]. Moreover, after cesarean section, mothers’ lack of capabilities lead to failure to breastfeed and to assume financial burdens on the family [19].

Some physician advise pregnant women to reduce their levels of physical activity, especially during the first trimesters, based on the belief that exercise would negatively affect pregnancy outcomes by increasing the risk of maternal abortion and induce musculoskeletal injury due to changes in posture and ligamentous laxity [20]. Prenatal general exercise has been recommended as the primary requirement of physiological pregnancy and birth by health-promoting organizations.

In 2010, the American College of Sports Medicine recommended that in the absence of contraindication, a minimum of three exercise sessions be completed with at least 15 min per session, gradually up to 30 min per day, preferably all days of the week [21].

Prenatal exercises are useful for both mother and fetus during pregnancy. Maternal benefits involve enhanced cardiovascular function [22], confined weight gain during pregnancy [23], reduced musculoskeletal injury [24], decreased occurrence of muscle spasm and lower limb edema [25], psychological support [26], a decrease of gestational diabetes and hypertension [23, 27], and less complicated labor [28]. Fetal benefits include decreased fat mass and improved neurobehavioral maturation [29].

Pregnancy more than childbirth affects pelvic floor function due to the hormones of pregnancy. These hormones are associated with relaxation of the pelvic floor connective tissue during the third trimester and labor. These effects decrease pelvic floor strength, which helps in childbirth [30]. The pelvic floor muscles (PFMs) consist of the urethral sphincter, the levator ani muscle, the anal sphincter, and other muscles, which support the pelvic organs like a hammock to keep them stable. Pregnancy and vaginal delivery may cause weakness of the PFMs. The association between antenatal PFM exercise and shortened first and second stage of labor is unclear [31].

Despite increasing knowledge regarding the effects of exercise during pregnancy, a general shortage of consensus persists regarding the impact of exercise on the type of delivery. Scientific evidence from experimental studies on the effect of exercise on the type of delivery
is limited and inexact [32]. Little information is available on the effects of antenatal PFM exercise on the mode of delivery because most studies were observational. Artal et al. [33] showed a reduced caesarean section proportion as a result of regular exercise. Proper antenatal exercises strengthen the PFM by 90%, which is essential for normal delivery [32]. Kaufmann and Hall [34] reported no relationship between antenatal exercise and mode of delivery. This study will help in the development of a protocol of care related to PFM exercise for pregnant women to facilitate the transfer of information between the physicians and physiotherapists working in prenatal clinics. In addition, it improves the physical therapy practice through integrating PFM training in maternal physical therapy curricula to equip physiotherapists with information and practical skills to make sure that physiotherapists working in antenatal clinics are aware of the importance and benefits of PFM training related to pregnancy outcomes.

Contradictory results and insufficient information have been reported regarding the effect of PFM exercises on mode of delivery, so the researchers found it is important to do this study among Egyptian women to investigate the effect of PFM exercise on mode of delivery.

**Subjects and Methods**

**Participants**

Twenty-two pregnant women aged between 20 and 25 years were recruited to the study and randomized into blocks by physician practices in the obstetric department (antenatal clinic) of the Sedi Salem Hospital, Kafrelsheikh, Egypt, from January to April 2016. The evaluation measures were explained to each participant. Two women did not attend the second visit.

Evaluations were performed in the antenatal clinic as well as the labor and delivery unit. The first evaluation was conducted at 20 weeks of gestation (WG). PFM strength was evaluated at 20 and 36 WG and labor outcomes were assessed from the birth registry after delivery.

The inclusion criteria were maternal age between 20 and 25 years, body mass index not exceeding 30, gestational age of 20 weeks, low-risk pregnancy, multigravida and singleton pregnancy, cephalic presentation, lack of regular physical activity during pregnancy, no use of cigarettes or narcotics, fetal heart rate of 120–160 beats per min, lack of diagnosed fetal malformations, mother’s inclination towards vaginal delivery, no medical problems at the beginning of the study, healthy sensory motor function in the lower limbs, and no musculoskeletal deformities.

Potential participants who were pregnant were excluded from the study if they were at less than 20 WG, if they were carrying more than one fetus, if there was a diagnosis of cephalo pelvic disproportion or a neonatal weight of either ≥4,000 or < 2,500 g, and if they had a history of gestational diabetes, preeclampsia, gestational hypertension, toxemia, or high-risk pregnancy. Women who also had a history of diabetes or history of cardiovascular, neurologic, neuromuscular, or respiratory disease or psychological illness were excluded.

During the examination, the participants were excluded from the study if they were unable to perform PFM contraction correctly, which was defined as squeeze by vaginal palpation or reporting pain. The subjects were allowed to leave the study at any time.

All pregnant women who fulfilled the inclusion criteria would be listed by nurses from the antenatal clinic. Subsequently, a researcher contacted the women, explained the purpose of the study, and invited all of them to participate in a session with a physical therapist for the evaluation of their ability to contract the PFM. During this session, the women were instructed about the anatomy of the PFM and how to perform a correct contraction. The PFM strength
was evaluated with vaginal squeeze pressure. After giving written consent form, the women were randomly allocated to the intervention group (IG) or the control group (CG).

This was a randomized controlled trial with blinding of examiners. The pregnant participants were randomized into blocks and allocated, using a simple, nonprobability sampling method, to either the IG \((n=10)\), in which women performed PFM exercises, or the CG \((n=10)\), in which women were given the usual antenatal care without exercises. Both groups received routine antenatal care.

The sample size was determined based on a pilot study by the researchers. All pregnant women participating in the pilot study were excluded from the study sample. The mean and standard deviation for the main outcome were measured by percentage of change from baseline during the previous study. Based on a sample with the power size estimation of the study beta of 80\%, and in order to detect the effect size of difference 5\%, with a significance level of \(p<0.05\), 20 participants were needed.

**Intervention**

The condition of the pregnant women randomized to the IG, who received PFM exercises for 4 months, was assessed at baseline and after 16 weeks (the end of the intervention). Neither group underwent physical therapy during the study.

The researcher discussed with pregnant women what the PFMs are, their functions, the advantages of PFM training as it increases the strength and elasticity of the PFMs, thus facilitating an easy passage of the fetus during second stage of labor and preventing the occurrence of stress incontinence and prolapsed after delivery, and how to detect the right muscle group for applying PFM exercise. The researcher instructed the pregnant woman to enter the bathroom to urinate and to try to stop the flow of urine in the middle of urination while she was sitting on the toilet. She should experience a feeling of squeezing and lifting at the same time. If she could do this, she was using the right muscles.

After that, the researcher provided instructions to the pregnant woman such as to breathe normally during the exercises, not to try to move her legs, buttocks, or abdominal muscles during the exercises, to relax for a period equal to the period of holding the contraction, and to increase the number of contractions gradually from one month to the next. To teach the exercise, the pregnant woman was told to contract the PFMs in the base of the pelvis by inserting two fingers into the vagina and to try to constrict the vagina. After that, she was taught to contract the muscles as she was trying to stop the flow of urine for a count of 6, equaling 6 s of contraction and another 6 s of relaxation, with 3 repetitions of 8 contractions with 2 min rest between repetitions. The PFM exercises were performed with the patient in the left lateral decubitus position, sitting and standing. These were repeated twice daily at home, three sessions per week. Participants were also instructed to contract the pelvic floor every time when coughing or sneezing. At 36 WG, the number of contractions/repetition was increased to 12. Those unable to follow this regimen due to the inability to contract the pelvic floor received individualized programs until they could follow the study regimen. The regimen was the one advocated by Bø [35] and similar to that recommended by the 2nd International Consultation on Incontinence [36]. Women in the IG received a handout explaining the training program. Besides, the exercise brochure and the application observation form developed by the researcher were handed out to participants, who were asked to register the exercises performed daily on the application form with the duration and frequency. The women in the IG were asked whether they had performed exercises when they came to control each week or through telephone calls from 20 WG to delivery. The physiotherapist responsible for the PFM training in the IG had experience in women’s health.

Women in the CG were not given any instruction with regards to PFM training, following the usual antenatal care, which does not include instructions regarding PFM exercise.
All participants in both groups were given an information pamphlet which included advice on normal care in addition to information about how to adopt a correct posture while sitting and standing, lifting, and carrying heavy objects, use of support pillows (especially while sleeping), and methods of turning over in bed or getting up from bed without exerting excessive strain on the lower back.

**Outcome Measures**

The primary outcome measure was PFM strength evaluated at 20 and 36 WG. PFM strength was measured by vaginal pressure during maximum voluntary contraction using Peritron®. Peritron has been found to have good intra- and intertester reliability [37, 38]. The assessment was performed in the crook lying position (supine position with both knees bent up) for all participants using a vaginal pressure measurement device. This perineometer (Cardio Design Pty Ltd., Oakleigh, VIC, Australia) is a conical vaginal electrode, 2.8 cm in diameter and 10.8 cm in length, with an active surface measurement length of 5.5 cm. The vaginal electrode is connected to a handheld microprocessor with rubber tubing, allowing for transmission of pressure readings in cm H2O when the electrode is compressed by external pressure. It is essential that the procedure used adheres to the locally agreed infection control policy. The electrode was covered with a sterile rubber sleeve for each patient.

The electrode was inserted into the vaginal canal until the full extent of the compressive part of the device was above the level of the hymeneal ring. The device was calibrated to zero before each measurement. The women were instructed to undertake three maximum PFM contractions with a rest of 30 s between contractions. Each contraction was held for 5 s. The mean value of the three contractions was used for analysis. Only contractions with visible observation of the perineum and probe getting inward were considered valid [39]. Gluteal and hip adductor muscles co-contraction was discouraged [38].

The secondary outcome measure were delivery outcomes collected from the medical registry after childbirth. The assistant was not involved in the randomization procedures or overseeing of the patients collected the data.

Data related to maternal status and labor progression was recorded on the examination form in both groups. At last, the proportions of vaginal and caesarean delivery were compared between the two groups.

**Data Analysis**

The collected data were categorized, tabulated, and analyzed and statistically described in terms of mean ± standard deviation as well as frequencies and percentages. The χ² test and the Student t test were used to analyze and compare data related to labor and newborn outcomes within each group and between groups before and after the intervention.

For the correlation between mean PFM strength and mode of delivery the Pearson correlation coefficient (r) was used. A p value <0.05 was taken to represent statistical significance. Data analysis was performed using Microsoft Excel 2007 (Microsoft Corp., NY, USA) and Statistical Package for the Social Science software version 15 (SPSS Inc., Chicago, IL, USA).

**Results**

Out of the 32 women originally contacted at their first antenatal visit, 22 fulfilled the inclusion criteria. Of these, 2 withdrew from the study, and 20 healthy gravid women (aged 23 ± 1.1 years) were randomly assigned to the IG (n = 10) or the CG (n = 10) (Fig. 1).

The baseline characteristics of the participants are shown in Table 1. There were no statistically significant differences between the two groups at baseline (p > 0.05).
The mean performance of PFM exercises in the IG was 42 ± 2.1 out of 48 possible sessions. Seven out of the 10 women in the IG (70%) performed at least 35 (72.9%) of weekly sessions at home. No hazards were reported by the participants.

In the IG, a statistical significant difference in mean PFM strength was found between 20 and 36 WG ($p < 0.05$). No change was found in the CG ($p > 0.05$). The $\chi^2$ test showed a significant difference between both groups in mean PFM strength at 36 WG ($p < 0.05$) (Table 2).

In the IG, 90% ($n = 9$) of women underwent spontaneous vaginal delivery, 10% ($n = 1$) vaginal delivery with episiotomy, and none caesarean section; however, these rates were 0% ($n = 0$), 50% ($n = 5$), and 50% ($n = 5$), respectively, in the CG. The $\chi^2$ test showed a significant difference between the two groups in terms of mode of delivery ($p < 0.05$) (Table 3).

In the CG, caesarean section was done in 20% ($n = 2$) of women due to active phase disorders, in 10% ($n = 1$) due to prolonged second stage of labor, and in 20% ($n = 2$) due to cord prolapse.

Mean PFM strength at 36 WG and mode of delivery were significantly correlated (vaginal delivery: $r = 0.58$, $p < 0.05$; caesarean delivery: $r = -0.49$, $p < 0.05$).

**Discussion**

Our study aimed to investigate the effect of PFM exercise on the mode of delivery in healthy pregnant women. The obtained results showed a significantly higher rate of vaginal delivery in mothers performing antenatal PFM exercise compared to the CG ($p = 0.000$). In the IG, 90% of participants underwent spontaneous vaginal delivery, while this rate in the CG was 0%.

Our findings are of clinical relevance because, in gravid women, previous results did not show that antenatal exercise is accompanied by a lower rate of normal deliveries [40, 41].
### Table 1. Baseline characteristics of the participants in the two groups

| Variables                              | IG (n = 10) | CG (n = 10) | p value |
|----------------------------------------|-------------|-------------|---------|
| Age, years                             | 23.2±1.5    | 22.6±0.9    | 0.72    |
| Body mass index                        | 25.16±2.3   | 26.3±1.4    | 0.51    |
| Educational level                      |             |             | 0.482   |
| Read and write                         | 2 (20%)     | 1 (10%)     |         |
| Primary school                         | 1 (10%)     | 4 (40%)     |         |
| Preparatory school                     | 4 (40%)     | 2 (20%)     |         |
| Secondary school                       | 2 (20%)     | 1 (10%)     |         |
| University                             | 1 (10%)     | 2 (20%)     |         |
| Occupation                             |             |             | 0.367   |
| Housewife                              | 8 (80%)     | 7 (70%)     |         |
| Office work                            | 1 (10%)     | 2 (20%)     |         |
| Manual work                            | 1 (10%)     | 1 (10%)     |         |
| Previous pregnancy complications       |             |             | 0.938   |
| Preterm labor                          | 1 (10%)     | 1 (10%)     |         |
| Vaginal tear                           | 2 (20%)     | 1 (10%)     |         |
| Premature rupture of membranes         | 1 (10%)     | 1 (10%)     |         |
| Vaginal infection                      | 6 (60%)     | 7 (70%)     |         |
| Type of delivery                       |             |             | 0.42    |
| Vaginal                                | 2 (20%)     | 1 (10%)     |         |
| Vaginal with episiotomy                | 3 (30%)     | 4 (40%)     |         |
| Forceps                                | 4 (40%)     | 4 (40%)     |         |
| Caesarean section                      | 1 (10%)     | 1 (10%)     |         |

Data are presented as mean ± standard deviation or n (%). CG, control group; IG, intervention group.

### Table 2. Comparison of mean PFM strength between the IG and the CG

| Gestational age | PFM strength (cm H2O) | p value |
|-----------------|------------------------|---------|
|                 | IG (n = 10)            | CG (n = 10) |       |
| 20 weeks        | 30.3±10.7              | 32.1±9.8  | 0.54   |
| 36 weeks        | 34.2±8.2               | 31.01±7.1 | 0.02   |
| p value         | 0.01                   | 0.41     |        |

Data are presented as mean ± standard deviation. CG, control group; IG, intervention group; PFM, pelvic floor muscle.

### Table 3. Comparison of mode of delivery between the IG and the CG

| Mode of delivery             | IG (n = 10) | CG (n = 10) | χ²   | p value |
|------------------------------|-------------|-------------|------|---------|
| Spontaneous vaginal delivery | 9 (90%)     | 0 (0%)      |      |         |
| Vaginal delivery with episiotomy | 1 (10%) | 5 (50%)     | 16.667 | 0.000   |
| Caesarean section            | 0 (0%)      | 5 (50%)     |      |         |

Data are presented as n (%). CG, control group; IG, intervention group.
When pregnant women are counseled about the mode of delivery, clear-cut information should be given to the morbidity associated with caesarean section, such as increased risks of postpartum bleeding, infection, pulmonary embolism, and paralytic ileus. Sultan and Stanton [42] suggest that the risk of serious maternal morbidity is considerably lower following vaginal delivery compared with caesarean section and that the hazard of hysterectomy following caesarean section is ten times higher than with normal childbirth.

Our results show a significant correlation between PFM strength at 36 WG and mode of delivery, with differences in type of delivery between both groups that are in apparent agreement with the American College of Obstetrics and Gynecology Committee, which considers that in the absence of contraindications, gravid women should be encouraged to participate in PFM exercise [43]. Other training studies have documented that regular exercise during pregnancy is associated with an increased rate of normal childbirth [34].

To our knowledge, this is the first study reporting correlations between mode of delivery and PFM strength using a reliable assessment tool [37, 38]. There was no statistically significant between-group difference in PFM strength at 20 WG (\(p > 0.05\)), and we found significant changes between both groups in PFM strength at 36 WG (\(p < 0.05\)). Little is known about the impact of the morphology and function of PFMs on variables that could affect the type of delivery.

In any case, the cross-sectional [44–46] or nonrandomized [34] nature of previous studies precludes a true cause-effect relationship from being established between exercise and type of delivery. Further, the etiologic mechanisms behind this reported association remain to be elucidated. PFM training during pregnancy is beneficial to both the body and mind. It can enhance blood circulation of the pelvic floor, strengthen the PFMs, and decrease venous compression caused by the gravid uterus and pelvic fat. It can also improve psychological well-being, facilitate natural childbirth, decrease the need for caesarean section, and reduce the incidence of dystocia [47].

Others have reported that antenatal PFM exercise may improve flexibility, strength, and motor control, facilitating the second stage of labor and decreasing the need for operative delivery and caesarean section [48–50]. Physical inactivity may also be associated with poor function of the PFMs, resulting in insufficient rotational forces and prolonged second stage of labor [51].

The relationship between physical activity and the incidence of instrumental delivery was examined in many other studies, all of which point in the same direction as our findings, although based on different physical activity levels. Erdelyi [52] documented that, among Hungarian athletes (\(n = 172\)), the percentage of cesarean section was 50% lower than in a control group (\(n = 184\)). Pregnant women who participated in an exercise program for at least 1 h twice a week for a minimum of 12 weeks were also more likely to have a spontaneous vaginal delivery than their non-athletic controls [28]. Another study showed that performing birth ball exercises for 4–6 weeks at the end of pregnancy could increase the rate of vaginal delivery [53].

Previous studies on the same topic also detected no between-group difference in the type of delivery when performing or not performing PFM training during pregnancy [49, 54]. Vaginal delivery is correlated with larger levator hiatus diameter and greater bladder neck mobility [55]. It is reasonable to propose that these gravid women may have less PFM strength [56].

Our results are in disagreement with data from a previous study which suggested that PFM training had no effects on delivery and newborn outcomes [55]. This is due to the fact that participants with a low socioeconomic status are more likely to receive insufficient prenatal care and to suffer from more violence, poor diet, and urinary tract infection during pregnancy.
The strength of our study is that it is, to our knowledge, the first investigation directly evaluating the effect of PFM exercise on mode of delivery, evaluated with accurate methods and not by self-completed questionnaires [50, 57], that we focused on participants representative of the general population and not on athletes, and that we used a randomized controlled trial design with blinded assessors, supervised follow-up of the participants, and long-term structured PFM exercise.

Our study is limited by its small number of participating pregnant women as well as the fact that accurate determination of the impact of antenatal PFM exercise seems to be a very difficult mission due to many variants that may be related to the development of psychological and physical conditions of pregnancy and women, including their lifestyle, diet, partnerships, professional obligations, economic situation, and many others [45, 58–60]. More studies with larger sample sizes are needed to confirm the effect of PFM exercise during pregnancy on the type of delivery.

Conclusion

Regarding the importance of promoting vaginal delivery among pregnant women, officiating antenatal PFM exercise is recommended as a safety, nonpharmacological, and inexpensive strategy for lowering caesarean section rates.

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Statement of Ethics

All participants provided written consent based upon research ethics committee approval by the Faculty of Physical Therapy, Cairo University (No. P.T. REC/012/001408). Official permission to carry out the study was obtained from the director of the antenatal clinic at the hospital as well as the director of the labor and delivery unit.

Disclosure Statement

The authors have no conflicts of interest to disclose.

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