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PHYSICAL ACTIVITY AND HEALTH

Ren, S., et al. (2020). The Effect of Pelvic Floor Muscle Training on Pelvic Floor Dysfunction in Pregnant and Postpartum Women. *Physical Activity and Health,* 4(1), pp. 130–141. DOI: https://doi.org/10.5334/paah.64

REVIEW

The Effect of Pelvic Floor Muscle Training on Pelvic Floor Dysfunction in Pregnant and Postpartum Women

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Background: Pelvic floor dysfunction (PFD) seriously affects the patients' quality of life, and its incidence is closely related to pregnancy and delivery. Pelvic floor muscle training (PFMT) is a conservative treatment of PFD. For decades, different researchers have conducted PFMT research on different female groups. However, the efficacy of PFMT for pregnant and postpartum women is controversial. Therefore, this article aimed to systematic review the efficacy of PFMT for them. This article reviewed the relationship between the occurrence and development of PFD during pregnancy and delivery, and the effect of PFMT on PFD in pregnant and postpartum women.

Method: We used the keywords of "pelvic floor dysfunction" and "pelvic floor muscles training", and focused on the study of PFMT during pregnancy and postpartum. Finally, 54 related studies were selected, including randomized controlled trials, quasi experimental trials, observational studies, longitudinal cohort studies, cross-sectional studies, and systematic reviews.

Result: During pregnancy, PFMT can prevent the occurrence of PFD in late pregnancy and early postpartum, and in the early postpartum period, PFMT can improve the symptoms of PFD. PFMT has a protective effect on the pelvic floor without obvious negative effects. However, PFMT has not been popularized in pregnant and postpartum women. And its beneficial effects cannot be maintained for a long time if women cannot insist on it for a long time.

Conclusion: The popularization and standard guidance of PFMT during the pregnancy and postpartum period should be strengthened vigorously in hospital. The development of a personalized PFMT program according to the individual situation of pregnant and postpartum women can improve the pelvic floor symptoms and their quality of life of women.

Keywords: Pelvic floor disorders; Pelvic floor muscles training; pregnancy; women

Introduction

Pelvic floor dysfunction (PFD) is related to weak supporting tissue structures, degeneration, trauma and other factors, including urinary incontinence (UI), pelvic organ prolapse (POP), and sexual dysfunction (SD). It can affect the women' quality of life seriously. The causes of PFD are complex, especially during pregnancy and delivery (Bozkurt et al. 2014; Dasikan et al. 2020). The physiological changes during pregnancy (including the mechanical function of enlarged uterus, the changes of estrogen and progesterone) lead to the weakening of the pelvic floor support structure. The compression of pelvic floor muscles, the injury of perineal nerve during vaginal delivery and the mechanical injury caused by dystocia and assisted delivery all play an important role in the occurrence of PFD (Bozkurt et al. 2014; Freeman 2013; Shek et al. 2012). In an observational study of primiparous women, at least one symptom of PFD was reported by 64% of women

1 year after first delivery (Michal et al. 2015). Therefore, it is of great significance to prevent and treat PFD during pregnancy and postpartum.

The clinical therapeutic schedule of PFD includes conservative treatment and surgical treatment, which depends on the severity of the patient's condition and personal wishes. Conservation treatment, including lifestyle advice, pelvic floor muscle training (PFMT), electrical stimulation, biofeedback, and pessaries (Hagen and Thakar 2015), is suitable for patients with mild to moderate PFD, and can also be used as an auxiliary treatment before and after severe surgery. Compared with other treatment methods, PFMT is neither limited by the location nor needs other additional instruments. PFMT is a kind of exercise to instruct patients to shrink the rectum. Patients relaxed after more than 3 seconds contraction of pelvic floor muscles (PFMs), 10–15 minutes each time, and 2–3 times a day. Patients can strengthen their pelvic floor support after performing PFMT for a long time. For decades, different researchers have conducted PFMT research on female in different age groups. However, the efficacy of PFMT for pregnant and postpartum women is controversial, and there are few systematic reviews on the efficacy of PFMT for them. This article reviewed the relationship of occurrence and development of PFD during pregnancy and delivery, and the effect of PFMT for PFD in pregnant and postpartum women.

Method

Search strategy

Literature search strategy was mainly based on one electronic database, PubMed. English-language searches using the following keywords: "pelvic floor dysfunction" and "pelvic floor muscles training". The search literature was limited to publication dates from 1983 to september 2020.

Inclusion criteria

In the process of searching literature, studies were mainly selected from five aspects: participants, training duration, interventions, primary outcome, main findings. All five aspects of the selected paper must meet the following inclusion criteria: 1) All subjects in the experimental group must be in pregnant or postpartum women, and the control group must match the gender and age of the experimental group. 2) Only studies with clear findings were included in this review. 3) The studies ought to aim at comparing the effects of PFMT on improving the pelvic floor symptoms and quality of life of pregnant and postpartum women with other treatment methods. All the included articles were published in peer-reviewed journals with full-text available.

Exclusion criteria

The articles were excluded if they meet the following criteria: 1) The above five aspects were incomplete. 2) The full text not available.

Data extraction

The search flowchart was shown in **Figure 1**. 716 related articles were found in PubMed. Focus on the study of PFMT during pregnancy and postpartum. Finally, 9 articles were included in this review. Five of them assessed pelvic floor muscle training on PFD at about 20 weeks of gestation and the other four articles evaluated the effect of pelvic floor muscle training on PFD after childbirth.

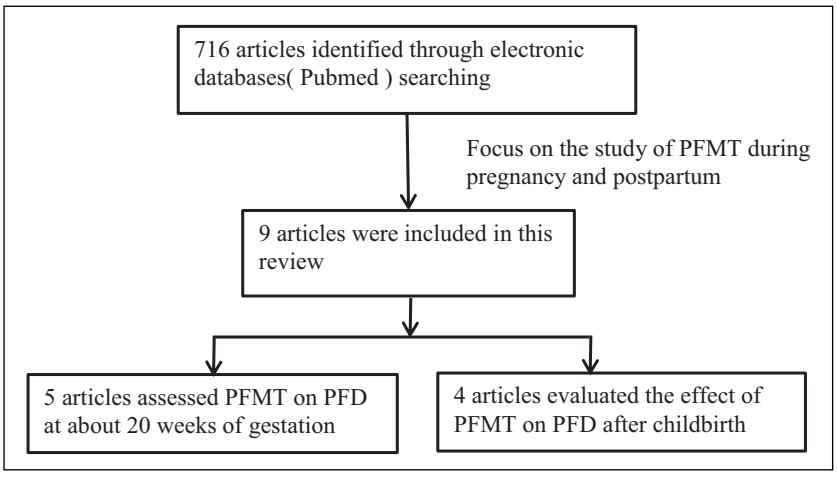

Figure 1: The flowchart of literature searching and screening.

The effect of pregnancy and delivery on pelvic floor

The incidence of PFD is closely related to pregnancy and delivery. The changes in anatomy and physiology during pregnancy can affect the structure and function of pelvic floor and can lead to the occurrence of PFD. Pregnancy, especially first pregnancy, is closely related to the decrease in levator ani strength, downward movement of bladder neck, increase in bladder neck mobility, downward movement of pelvic organs, and decrease in urethral resistance (Hans et al. 2018). The cervix and vaginal tube are pulled up as a consequence of enlarged uterine size during pregnancy, and the pelvic organs leave out of original location (Reimers et al. 2016). With the increase in gestational age, the weight and volume of uterus also increase significantly. Because the pelvic floor has been oppressed for a long time, the muscles and nerves of the pelvic floor are damaged. During pregnancy, a large amount of progesterone is secreted in pregnant women to maintain pregnancy, which has been proved to be a smooth muscle relaxant. As the main body of pelvic floor structure, PFM contains a significant amount of smooth muscle fibers, and progesterone receptors in the PFM and urogenital ligaments (Smith 1993). With the development of pregnancy, the increase in progesterone secretion may have negative effects on pelvic floor support, bladder, and urethra tension. In addition, the study found that in the late pregnancy, the prevalence of symptomatic POP was 26%–37% (Sze et al. 2002; Amy et al. 2005). Elective cesarean is only partially effective in preventing POP, and it can prevent up to 74% of symptomatic POP (Sze et al. 2002; Handa et al. 2009). It indicates that pregnancy itself can be a risk factor for pelvic floor disease, and the mechanical and hormonal changes of pregnancy may have an irreversible effect on the pelvic floor.

Many studies have shown that vaginal delivery can damage the structure of the pelvic floor. According to the biomechanical model of Oliveira et al., it is predicted that even an apparently uneventful vaginal delivery will cause injuries to PFM, especially when the fetus head is extending, and more than 10% of PFM fibers can be damaged. The puborectalis component of the levator ani muscle is the most prone to damage (Oliveira et al. 2016). When using forceps for midwifery, the possibility of 53%-66% can cause the levator ani injury (John et al. 2007; Rohna et al. 2006). Permanent nerve injury, avulsion of a muscle, and rupture of connective tissue under the skin during vaginal delivery can result in sustained damage to the pelvic floor support structure. However, due to the strong reserve capacity of the pelvic floor of young women, this damage may not become immediately visible in all cases (John et al. 2008).

With the increase in age and the number of parity and other factors, the supporting effect of pelvic floor structure will gradually weaken, and then the symptoms of PFD will appear (Hwang et al. 2019; Bodner-Adler et al. 2019). UI persisted to 6 even 12 years in about three-quarters of women who were found UI at 3 months after first birth. Research showed that more than 5/6 of women who had UI before pregnancy would still suffer from UI problems 12 years after first childbirth (MacArthur et al. 2006; MacArthur et al. 2016).

The effect of pelvic floor muscles training on pelvic floor dysfunction during pregnancy

PFMT is a conservative treatment for PFD, which was originally put forward by Dr. Kegel, also known as Kegel exercise (KEGEL 1948). It is a kind of repetitive PFM autonomic contraction movement aiming at strengthening PFM and its surrounding muscles (KEGEL 1948). With the continuous attention to the conservative treatment of PFD, PFMT has developed from a possible blind PFM contraction to a repeated structured program with different intensity and duration of PFM autonomic contraction; what's is more, researchers continue to enrich the PFMT scheme. Nowadays, PFMT is mainly guided and regularly supervised by an experienced practitioner.

PFMT consists of three parts: theoretical guidance, supervised PFMT program and self-daily training at home. Theoretical guidance generally includes the anatomy and function of the pelvic floor, the mechanism of PFD, the role of PFMT in PFD, and the suggestions on lifestyle, so women can have a positive impression of PFMT and women's enthusiasm can be improved. The supervised PFMT program can be a one-to-one mode or a group mode, with generally no more than 15 people. The key point of the supervised PFMT program is guiding women to perform correct PFM self-contraction. The frequency of the program varies from once a week to once a month, each time lasting about 45–60 minutes. The self-daily training at home is mainly supervised by the personal training diaries recorded by women. The daily training is generally 8–12 times of maximum PFM contraction twice a day, and the individualized PFMT program is developed according to the regular supervision courses of the instructors. The duration of PFMT varies from 6 weeks to 6 months (Kari et al. 1990; Hagen et al. 2009; Ingeborg et al. 2010; Liliana et al. 2011; Kashyap et al. 2013).

The pelvic floor muscles can be protected if women perform the PFMT during pregnancy, and, it has a significant effect on preventing the injury of levator ani muscle. The size of the hiatus of levator ani muscle is related to the symptoms and signs of POP (Dietz et al. 2008), so it can be used as an anatomical alternative indicator for evaluating PFM function (Ouchi et al. 2019). The area of hiatus of levator ani muscle

is bounded by pubic muscle, symphysis pubis and inferior branch of pubis. The area of hiatus in women with POP was 50% larger than that in normal women (John et al. 2007). Pregnancy may be an important risk factor affecting the hiatus of levator ani muscle. Shek et al. used transperineal ultrasound to find out that comparison of third trimester data of the pregnant cohort with that of the nullipara displayed a 27% and 41% enlarge in hiatal area at rest and Valsalva. There was 70% possibility that the increased area can still remain for 4 months after delivery (Shek et al. 2012). In a prospective study of 300 pregnant women who were in their sixth week after childbirth, it was found that the larger the area of hiatus, the more easier to occur POP (Cathrine et al. 2019).

The area of hiatus of levator ani muscle can be reduced if the woman persist in preferring PFMT program for a long time. When PFM was contracted autonomously, the area of hiatus decreased on average 24% (Kari et al. 2009). When PFMT was maintained for 6 months, the area of hiatus in POP women could be reduced by 1.5 cm^2 on average (Ingeborg et al. 2010). In addition, PFMT can also cause a series of morphological changes of PFM, such as increasing the thickness of PFM, shortening the length of PFM, raising the bladder neck, and reducing the mobility. In the activities with increased internal pressure, such as running and coughing, it can prevent the bladder and urethra from moving down (Maria et al. 2016). These changes in the morphology and structure of the pelvic floor have a positive impact on promoting the repair of pelvic floor muscle tension and restoring the function of the pelvic floor. When the PFMT program is implemented in the middle of pregnancy, it can prevent about 1/6 of late pregnancy women and 1/8 of postpartum women from developing UI and can significantly improve the muscle strength of PFM (Siv et al. 2003). There are some studies of PFMT intervention in pregnant women at about 20 weeks of gestation in **Table 1**.

Although PFMT can make PFM fiber hypertrophy and improve the muscle strength of PFM, its effect will not have a harmful effect on vaginal delivery. Many studies have shown that antenatal PFMT resulted in improved muscle control and strong flexible muscles, and it might be effective at shortening the first and second stage of labor (28 min and 10 min respectively) in the primiparas (Du et al. 2015). What's more, it can prevent about 1/8 of women from having a second stage of labor for a long time (Salvesen and Mørkved 2004). Antenatal PFMT may not increase the risk of perineal laceration, episiotomy, instrumental delivery and emergency cesarean section in the primiparas (Agur et al. 2008; Kari et al. 2009; Du et al. 2015). Therefore, it is beneficial and safe for pregnant women to carry out PFMT during pregnancy, and pregnant women can be encouraged to perform PFMT from the middle of pregnancy.

For women who exercise regularly before pregnancy, they can choose to take the PFMT program with increased aerobic exercise, and the relevant information of the program is listed in **Table 1**. This program can help women to continue high-intensity exercise during pregnancy, and it not only have harmful effects on the function of the pelvic floor, but also can improve the neuromusclar activity of the pelvic floor, improve the relaxation ability of PFM, prevent the occurrence of postpartum UI, and improve the quality of life of women (Dornowski et al. 2018; Szumilewicz et al. 2019; Szumilewicz et al. 2020).

The effect of pelvic floor muscles training on pelvic floor dysfunction after childbirth

More than one third of women may suffer from UI and/or POP after giving birth (Woodley et al. 2017; Sze et al. 2002), which not only affects their quality of life, but also the vast majority of women do not seek medical treatment in time at this stage, making their condition more serious. The occurrence of PFD in late pregnancy and early postpartum can be prevented if women perform PFMT during pregnancy. What's more, the symptoms of PFD can be improved if women perform PFMT during the early postpartum.

Table 2 lists some studies of PFMT in postpartum. Performing PFMT can not only reduce the prevalence of postpartum UI, but also improve the muscle strength and endurance of PFM (Siv and Kari 1997; Sigurdardottir et al. 2019). However, a certain amount of exercise dose must be observed, such as the type, frequency and intensity of exercise, as well as the duration of the training cycle. Compliance with training regimen is most important for prevention even treatment of postpartum UI and persistent UI. Previous study suggested three sets of 8 to 12 slow maximal contractions sustained for 6–8 seconds each, performed three to four times a week and if people could continue for 15–20 weeks, they would get a better effect on prevention even treatment of postpartum UI (Dumoulin 2006). Although PFMT could reduce the short-term UI prevalence within 1 year after delivery, in the long run, the number of people who could carry out PFMT regularly was small, and the UI prevalence increased (Glazener et al. 2005).

Kari et al. found that even after 4 months of postpartum PFMT treatment, the conscious symptoms of POP patients, such as vaginal prolapse and objective perineum ultrasound evaluation of bladder neck position

Table 1: Summary of studies' assessment of pelvic floor muscle training on PFD during pregnancy.

Reference	Participants/GW	Training duration	Interventions	Primary outcome	Main findings
Reilly et al. 2002	268 nulliparous with bladder neck mobility; GW 20th	until delivery	Exp (n = 139): supervised PFMT + self-daily training Con (n = 129): verbal advice on PFMT Supervised PFMT program: one-to-one, every month; Self-daily training at home: 3 repetitions of 8 contractions for 6 s with 2 mins rest between repetitions (repeated BID). At 34th GW, the number of contractions per repetition was increased to 12.	Subjective reporting of SUI at 3 months postpartum.	Antenatal supervised PFMT can reduce the risk of postpartum SUI effectively in primigravidae with bladder neck mobility.
Siv et al. 2003	310 nulliparous; GW 20th	12 weeks	Exp (n = 148): supervised PFMT + self-daily training Con (n = 153): received the customary information supervised PFMT program: 10–15 participants, 60 minutes per session, every week, 12th times. perform near-maximal PFM contractions, and hold the contraction 6–8 s. At the end of each contraction, add 3–4 fast contractions with about 6 s resting period; Self-daily training at home: 8–12 equally intensive PFM contractions BID.	Self-reports of UI at 36th GW and 3 months after childbirth	Intensive PFMT during pregnancy prevents UI during pregnancy and after delivery.
Salvesen and Mørkved 2004	301 nulliparous; GW 20th	12 weeks	Exp (n = 148): supervised PFMT + self-daily training Con (n = 153): received the customary information supervised PFMT program: 10–15 participants, 60 minutes per session, every week, 12 times. Perform near maximal PFM contractions, and to hold the contraction 6–8 s. At the end of each contraction, add 3–4 fast contractions with about 6 s resting period; Self-daily training at home: 8–12 equally intensive PFM contractions BID.	Duration of the second stage of labor and the rate of prolonged second stage*	A structured PFMT is associated with fewer cases of active pushing in the second stage of labor.
Agur et al. 2008	268 primigravidae with antenatal bladder neck mobility; GW 20th	until delivery	Exp(n = 139): supervised PFMT + self-daily training Con(n = 129): verbal advice on PFMT supervised PFMT program: one-to-one, every month; Self-daily training at home: 3 repetitions of 8 contractions for 6 s with 2 mins rest between repetitions (repeated BID). At 34th GW, the number of contractions per repetition was increased to 12.	The duration of the second stage of labour and the incidence of instrumental deliveries	PFMT during pregnancy does not facilitate or obstruct labour or result in a higher incidence of prolonged labour* or instrumental delivery.

Reference	Participants/GW	Training duration	Interventions	Primary outcome	Main findings
Szumilewicz et al. 2019	97 nulliparas; GW average 21th	6 weeks	Exp (n = 70): high-low impact aerobics + PFMT Con (41) = no training high-low impact aerobics + PFMT: 3 times a week, every 2 weeks check the quality each session consisted of: a warm up, aerobics in the form of high- and low-impact aerobic choreography with music (25 min), strength conditioning exercises (25 min), and stretching and breathing exercises and relaxation (10 min).	PFM EMG	Prenatal exercise programs that include high- and low-impact aerobics and are supported by PFMT should be recommended for pregnant women.

BID = twice a day; Con = control group; EMG = electromyogram; Exp = experimental group; GW = gestational week; PFM = pelvic floor muscles; PFMT = pelvic floor muscles training; SUI = stress urinary incontinence; UI = urinary incontinence.

* The prolonged second stage is the time of active labor is longer than 60 minutes.

Table 2: Summary of studies' assessment of pelvic floor muscle training on PFD after childbirth.

Reference	Participants/after delivery	Training duration	Interventions	Primary outcome	Main findings
Siv and Kari 1997	196 mothers; 8 weeks	8 weeks	Exp (n = 99): supervised PFMT + self-daily training Con (n = 99): followed the ordinary written postpartum instructions from the hospital Superxised PFMT program: 5–10 participants, 45 mins once a week; Self-daily training at home: 8–12 maximum PFM contractions BID, hold the contraction for 6–8 s, at the end of each contraction 3–4 fast contractions were added.	The improvement of PFM strength and the number of women with UI.	PFMT is effective in increasing pelvic floor muscle strength and reducing UI in the immediate postpartum period.
Gunvor et al. 2013	175 primiparous women; 6 weeks	16 weeks	Exp (n = 87): superxised PFMT + self-daily training Con (n = 88): verbal advice on PFMT Superxised PFMT program: Once a week follow up; Self-daily training at home: 3 sets of 8–12 contractions close to maximum every day.	Self-reported UI	Postpartum PFMT did not decrease UI prevalence 6 months after delivery.
Kari et al. 2014	175 primiparous women; 6–8 weeks	16 weeks	Exp (n = 87): superxised PFMT + self-daily training Con (n = 88): verbal advice on PFMT Superxised PFMT program: Once a week follow up; Self-daily training at home: 3 sets of 8–12 contractions close to maximum every day.	POP stage II or greater assessed by POP quantification, bladder neck position and symptoms of vaginal bulge	PFMT had no effect on POP.
Sigurdardottir et al. 2019	84 primiparous women with UI; 9 weeks	until 6 months postpartum	Exp (n = 41): superxised PFMT + self-daily training Con (n = 43): no training Superxised PFMT program: 12 sessions, each 45–60 min,once a week.one session is 10 close to maximum contractions and 7 s holding periods with a 10 s rest between each contraction,during appointments 8–9, add 3 fast contractions at the end of each contraction and do so in the remaining sessions. Self-daily training at home: 10 close-to-maximum PFM contractions, 3 sets/day + the Knack*	the rate of urinary and/or anal leakage	Postpartum PFMT decreased the rate of UI, increased muscle strength and endurance.

BID = twice a day; Con = control group; Exp = experimental group; PFM = pelvic floor muscles; PFMT = pelvic floor muscles training; UI = urinary incontinence.
* The knack is that patients are instructed to contract the pelvic floor every time when coughing or sneezing.

did not significantly improve. They thought this phenomenon may be related to the level of physical activity of women. Six weeks postpartum women might not yet have returned to their optimal physical activity level, and the symptoms of POP were not shown. With the prolongation of postpartum time, the time of women participating in sports activities increased, and POP related symptoms would not appear until 6 months postpartum (Kari et al. 2014).

Discussion

PFMT is performed by contracting and relaxing muscles of the pelvic floor. A correct contraction consists of a squeeze around the pelvic openings followed by an inward cranial lift (Susanne et al. 2013). There is Level 1, Grade A evidence that PFMT is effective in treatment of SUI (Kari 2012).

There are two hypotheses to explain the effectiveness of PFMT for FPD: 1. Women learn to consciously contract before and during increase in abdominal pressure (such as coughing and physical activity) and continue to perform such contractions as a behavior modification to prevent leakage and descent of the pelvic floor; 2. women are taught to perform regular strength training over time in order to build up "stiffness" and structural support of the pelvic floor (Kari 2006; · Kari 2006). However, 66% of the women were not able to perform a correct PFM contraction at baseline (Susanne et al. 2013). Even after thorough instruction 4% were unable to contract correctly (Hilde et al. 2012). In clinical practice, the ability to correctly contract the PFM is essential to training. Prior to PFMT program for women, methods such as vaginal palpation, vaginal cone, biofeedback, interruption of urinary flow, and visualization using a mirror can be used to guide women to perform correct PFM contraction, and the effect of these programs is similar (Elaine et al. 2018).

The duration of PFMT is long, and the dropout rate is high, which requires high compliance and close supervision to achieve its maximum effect. After 6 months of supervised PFMT program, the pubovisceral muscle thickness was increased and length was shortened, the levator hiatus area was decreased, and the position of the bladder and rectum was elevated at rest. Additionally, the hiatal area and muscle length were reduced at maximum Valsalva indicating supervised PFMT program could increase pelvic floor muscle stiffness (Ingeborg et al. 2010). Most of the symptomatic women thought that after PFMT, their quality of life had improved significantly, and there was no evidence that PFMT had obvious adverse side effects.

In a study of 300 women with first trimester pregnancies, it was found that PFMT was not widely popularized in pregnant women, 89% had heard of PFMT at mid pregnancy, while only 35% performed PFMT once or more a week without supervision and feedback (Hilde et al. 2012). Not only can the short-term benefits of PFMT be maintained after childbirth, but also the beneficial effects of PFMT cannot be sustained for a long time even if it is started from the middle of pregnancy (Reilly et al. 2002; Agur et al. 2008). Therefore, the popularization and standard guidance of PFMT during pregnancy and postpartum period should be strengthened vigorously. In addition, for women with significant risk factors, such as more births, and women with PFD symptoms, it is necessary to develop further supervised and strengthened PFMT program to maintain its long-time effect.

Conclusion

The pathogenesis of PFD is closely related to pregnancy and childbirth. PFMT, as a conservation treatment to prevent and treat PFD, has a protective effect on the pelvic floor, and its safety has also been confirmed. At present, the major hospitals in China have begun to pay attention to the repair of female pelvic floor function, but the importance of pelvic floor muscle exercise for pregnant women is still low.

The PFMT is simple and easy to master and has high clinical application value. We should strengthen the popularization and standard guidance of PFMT during pregnancy and postpartum. However, because of the different situation of pregnant women, we should draw up personalized PFMT program according to the individual situation of pregnant and postpartum women. To prevent and treat PFD, improve the quality of life, improve the symptoms of pelvic floor, and avoid the surgical treatment, it is also recommended to perform PFMT as soon as possible after delivery.

Abbreviations

Full name	Abbreviation
control group	Con
electromyogram	EMG
experimental group	Exp
gestational week	GW
Pelvic floor dysfunction	PFD

pelvic floor muscles	PFM
Pelvic floor muscles training	PFMT
pelvic organ prolapse	POP
sexual dysfunction	SD
stress urinary incontinence	SUI
twice a day	BID
urinary incontinence	UI

Funding Information

Fund project: Zhejiang Province Medical and Health Science and Technology Plan Project (Research on the safety of astaxanthin and its mechanism in preeclampsia, Number: 2018KY710). Ningbo Public Welfare Science and Technology Plan Project (Early screening and intervention of antioxidant nutrition in hypertensive disorders of pregnancy, Number: 2019C50095). Science and Technology Development Foundation Item of Nanjing Medical University (The role of VWTSP-1 in the prevention and treatment of stress urinary incontinence, Number: 2018119).

Competing Interests

The authors have no competing interests to declare.

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How to cite this article: Ren, S., Gao, Y., Yang, Z., Li, J., Xuan, R., Liu, J., Chen, X., & Thirupathi, A. (2020). The Effect of Pelvic Floor Muscle Training on Pelvic Floor Dysfunction in Pregnant and Postpartum Women. *Physical Activity and Health,* 4(1), pp. 130–141. DOI: https://doi.org/10.5334/paah.64

Submitted: 10 September 2020 **Accepted:** 08 October 2020 **Published:** 29 October 2020

]u[*Physical Activity and Health* is a peer-reviewed open access journal published by Ubiquity Press.

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