

# The effect of water immersion delivery on the strength of pelvic floor muscle and pelvic floor disorders during postpartum period

## An experimental study

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### Abstract

**Background:** Water immersion delivery is a non-pharmacological approach to ease labor pain. This paper aims to investigate the effect of water immersion delivery on increasing strength of pelvic floor muscle (PFM) and relieving pelvic floor disorders (PFDs) during postpartum period.

**Methods:** A total of 2749 vaginal-delivery primiparas in postpartum 6-8 weeks were selected as research objects. Based on the modes of delivery, 600 patients were assigned into water immersion delivery group, 2149 were assigned into conventional delivery group. The scales of PFM strength and pelvic organ prolapsed (POP) were determined by specially trained personnel using digital palpation, and the symptoms of stress urinary incontinence (SUI) were investigated by questionnaire survey. The weak PFM strength was improved by doing Kegel exercise at home for 6-8 weeks.

**Results:** We found that ①The rate of episiotomy in water immersion delivery group was 77.50% (465/600), which was lower than that in conventional delivery group (84.69%, 1820/2149) ( $P < .01$ ); The primiparas without having an episiotomy have higher PFM strength than those having an episiotomy for both groups ( $P < .01$ ). ②There was a negative correlation between the scale of PFM strength and SUI or POP, wherein the  $r$ -values were  $-0.135$  and  $-0.435$ , respectively ( $P < .01$ ). ③The rate of SUI was 6.50% (39/600) in water immersion delivery group and 6.89% (148/2149) in the conventional delivery group, wherein the intergroup difference was not significant ( $P > .05$ ); ④The rates of vaginal wall prolapsed and uterus prolapsed were 29.83% (179/600) and 2.83% (17/600) in water immersion delivery group and 30.95% (665/2149) and 4.37% (94/2149) in the conventional delivery group, wherein the intergroup difference was not significant ( $P > .05$ ). ⑤After Kegel exercise, the strength of PFM was promoted ( $P < .01$ ).

**Conclusion:** Water immersion delivery has been proved to a beneficial alternative method for conventional delivery method. This delivery mode is associated with fewer episiotomy rate, and avoiding episiotomy is beneficial for maintaining PFM strength of women in postpartum 6-8 weeks. The strength of PFM during postpartum period can be improved by doing Kegel exercise at home.

**Abbreviations:** ACOG = American College of Obstetricians and Gynecologists, PFBQ = the Pelvic Floor Symptom Bother Questionnaire, PFDs = pelvic floor disorders, PFM = pelvic floor muscle, POP = pelvic organ prolapsed, POP-Q = Pelvic Organ Prolapse Quantitative, SUI = stress urinary incontinence.

**Keywords:** pelvic floor disorders, pelvic floor muscle, water immersion delivery

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## 1. Introduction

Pelvic floor disorders (PFDs) are one of the most common diseases among adult women, and pregnancy and childbirth are independent risk factors of PFDs according to epidemiological studies.<sup>[1,2]</sup> Female PFDs mainly include urinary incontinence, anal incontinence, pelvic organ prolapse (POP), and sexual dysfunctions, which causes considerable impact on life quality of one-third of adult women in the United States.<sup>[3]</sup> Under such context, many Chinese women have requested cesarean delivery. There are 2 different modes of water birth: one is to apply water immersion during the first stage of labor, which is called immersion therapy; the other is to apply water immersion for the first and second stage of labor as well as underwater delivery, which is called underwater birth. In American College of Obstetricians and Gynecologists (ACOG) recommendation,<sup>[4]</sup> immersion in water during the first stage of labor may be suitable for full-term (from 37 0/7 to 41 6/7 pregnant weeks) and low risk (without complication) pregnant women because it may be

associated with shorter duration of labor and decreased use of neuraxial analgesia. But as to underwater delivery in the second stage of labor, the safety and efficacy have not been established. It may be occurred serious adverse effects in the newborn including drowning, severe respiratory distress, and so on. So birth occurs on land, not in water, recommended by ACOG. In this paper, immersion therapy was used as a nonpharmacological analgesic method based on individual needs. In addition, for those who were not allowed to be immersed in water as part of fetal head being visible, immersion therapy was regarded as an optimal choice. The conventional delivery refers to lying on the bed. The primary aim of this study is to observe whether water immersion therapy can influence the pelvic floor muscle (PFM) strength and PFDs such as stress urinary incontinence (SUI), POP at postpartum 6 to 8 weeks when the patients come back for reexamination or questionnaire survey, and to observe the effect of doing Kegel exercise at home for 6 to 8 weeks from January 2013 to January 2014 on improving the strength of PFM.

## 2. Materials and methods

### 2.1. Study population

In this case-controlled study, the researched objects were women at postpartum 6 to 8 weeks who had been treated in pelvic floor rehabilitation department in the Mother and Children Health Care Hospital of Hubei Province from January 2013 to January 2014. The postpartum period, also known as the puerperium, begins with the delivery of the baby and placenta. The end of the postpartum period is less well-defined, but generally considered the 6 to 8 weeks after delivery when the effects of pregnancy on many systems are almost disappeared. The aim of the study was to investigate the effect of water immersion delivery on pelvic function during postpartum period. Inclusion criteria included Chinese women, aged 20 to 40 years, primipara, singleton pregnancy, delivery after more than 37 gestational weeks, vaginal delivery, clean lochia, no serious complications such as severe cardiopulmonary diseases, renal diseases, or insulin-dependent diabetes mellitus. Exclusion criteria included age less than 20 years or older than 40 years, non-Chinese, cesarean delivery, multipara, multiparous pregnancy, having vaginitis and urinary tract infection, or mental incapacity and so on. A total of 2769 patients were selected in this study, excluding 20 patients who could not cooperate with specially trained nurses to do questionnaire survey nor with specialists in digital palpation. According to the difference in delivery mode, 2749 patients were divided into 2 groups, that is, water immersion therapy group (Immersion Group), and conventional delivery group (Conventional Group). Regarding the Immersion Group, there was a normal obstetric bed and a birthing pool (Apal et Sunset, Belgique, Belgium) in water delivery room, and the temperature was kept within 24°C to 26°C. The maximum capacity of birthing pool was 500 L, with external dimension of 755 × 1820 × 1440 mm<sup>3</sup> (height, length, width), and the internal dimension of 595 × 1550 × 1100 mm<sup>3</sup>. The door width of water delivery room was 450 mm and the maximum angle was 115°. The water temperature was controlled within 35°C to 38°C. The water was deep enough to cover her abdomen, so the woman in the pool had enough space to adapt to different positions (semirecumbent, floating/supine, squatting, kneeling, moving around in the water). Women in this group first accepted dilation of cervix to 3 cm or more, and then entered into the warm water pool for staying 1 to 6 hours. After that, they were subjected to full cervical dilatation

before leaving the water pool, and then laid on a normal delivery bed. Patients in this group were required to leave the pool intermittently upon feeling too hot or cold, or showing abnormal heart rate, abnormal blood pressure, or abnormal babies' heart rate. Labor onset of women in Immersion Group could be spontaneous and induced. 0.5% to 1% oxytocin was routinely applied to strengthen contractions in case of uterine atony. When patients left water during second stage of labor, their treatment processes were the same as the patients in Conventional Group. Mediolateral episiotomy was performed at crowing in primiparous. Fetal scalp was protected by midwives before incision. Operative vaginal delivery (vacuum or forceps) was conducted involving an incision of mediolateral episiotomy more than 4 cm. The scale of PFM strength and pelvic organ prolapsed (POP) at postpartum 6 to 8 weeks were examined by a specially trained doctor using digital palpation. Questionnaire survey on clinical symptoms of selected patients was conducted by 2 trained nurses, and all results were recorded truthfully. All selected patients did not accept PFM training during pregnancy and in postpartum 6 to 8 weeks. The study was approved by the Ethics Committee of Mother and Children Health Care Hospital of Hubei Province in China (No. 201201). Before conducting the water immersion therapy, digital palpation of PFM strength, and questionnaire, the written informed consents of patients were obtained.

### 2.2. Questionnaire survey of SUI

The investigation was performed by specially trained nurses at postpartum 6 to 8 weeks by unified questionnaire and unified discourse. The questionnaire was processed seriously, and objective answers were collected from patients. Diagnostic criteria<sup>[5]</sup>: the questionnaire included 4 descriptions on the symptoms of SUI: The urine routine was normal, no nervous system diseases, excluding other diseases of urinary system, uncontrollable leakage of urine in coughing, sneezing, laughing, sudden increase of abdominal pressure, or position changing.

### 2.3. Determination of PFM strength

The evaluation of PFM strength and routine physical examination were performed by trained specialists using digital palpation, and examination results were recorded truthfully. Before the examination, the tested women were subjected to bladder emptying and posed in the supine position with both knees half bent. PFM contraction without any visible contraction of the glutei, hip, or abdominal muscles was emphasized.<sup>[6]</sup>

With regard to digital palpation,<sup>[7,8]</sup> the physiotherapist put the index and middle fingers 2 to 3 cm into the vagina and identified the levator ani muscle, and then separate 2 fingers and position them on 2 sides of levator ani muscle. Meanwhile, put the other hand on the abdomen of the patient to make sure the abdominal muscle was relaxed. The scale of PFM strength was described by modified Oxford grading system.<sup>[8]</sup> According to the capacity of PFM contraction and retraction, the PFM strength was divided into 0 to 5 grades and 6 classes. 0: no contraction, 1: flicker, 2: weak, 3: moderate, 4: good, and 5: strong (Table 1).

### 2.4. The diagnosis of POP

Regarding the diagnostic criteria,<sup>[9]</sup> POP was divided into 3 defects including anterior pelvic defects, intermediate pelvic defects (uterine and vaginal vault prolapsed), and posterior pelvic defects. In this study, both anterior and posterior vaginal wall

**Table 1**  
**Modified Oxford scale for digital evaluation of pelvic floor contraction strength.**

Grade	Description
0	Nil
1	Flicker
2	Weak
3	Moderate, slight lift of the examiner's fingers, no resistance
4	Good, sufficient to elevate the examiner's fingers against light resistance
5	Strong, sufficient to elevate the examiner's fingers against strong resistance

prolapsed were discussed. Formulated by America Society of Obstetrics and Gynecology in 1995, POP-Q (Pelvic Organ Prolapse Quantitative examination) evaluation system is the most frequently used system in the present, which uses the plane of the hymen as a point of reference (0) and measures the distance of defined points to the hymen.

**2.5. PFM training**

When the scale of PFM during postpartum period was <2 grades, the specialists would teach them how to contract their PFM by demonstrating vaginal palpation, which was first described by Kegel.<sup>[10]</sup> At the beginning, the specialists placed one finger into one-third of the vaginal and asked the women to lift inward and squeeze around the finger, so as to teach them how to contract PFM and judge whether their contraction of PFM was correct or not. Then, the women took Kegel exercise at home, 10 sets of contractions a day, and each set included 10 repetitions. After doing Kegel exercise for 6 to 8 weeks, the women were told to come back again for PFM strength examination. The results showed that all the patients were satisfied with the results of their PFM strength.

**2.6. Statistical methods**

Statistical analyses were performed with software SPSS version 19.0 (SPSS, Inc., Chicago, IL). The data are presented in form of means ± standard deviations or percentage. *T* test was conducted for statistical comparison of quantitative data, while Chi-square analysis was carried out for statistical comparison of qualitative data. Wilcoxon test was performed to evaluate the difference of PFM function between 2 groups. Correlation analysis was conducted using method of Spearman. The difference was considered significant when *P* < .05.

**3. Results**

**3.1. The comparison of demographic data between Immersion Group and Conventional Group**

In this study, there were 600 patients in water immersion group and 2149 patients in the Conventional Group. Through statistical comparison, it could be found that the differences (age, BMI of delivery, birth weight) were not significant between the 2 groups, but Immersion Group had lower rates of episiotomy and operation vaginal delivery (77.50% and 1.00%) than Conventional Group (84.69% and 3.07%). The comparison of demographic data between 2 groups is shown in Table 2.

**3.2. The comparison of PFM strength scales of women at postpartum 6 to 8 weeks between the 2 groups**

The scales of PFM strength at postpartum 6 to 8 weeks of 2 groups were both affected by episiotomy. In this study, the women without having episiotomy had more powerful PFM strength than those having episiotomy for both the water immersion group and the Conventional Group (*P* < .05), and there was no significant difference in scale of PFM strength between the 2 groups the *Z* value was -0.759 and the *P* value was .448 (*P* > .05). The data are presented in Table 3.

**Table 2**  
**The demographic data between the 2 groups.**

	N	Age	BMI of delivery, kg/m <sup>2</sup>	Birth weight	Gravidity	Episiotomy (%)	Operation (%)
Immersion Group	600	27.56 ± 2.67	27.12 ± 2.51	3269.64 ± 427.22	1.36 ± 0.72	459 (77.50%)	6 (1.00%)
Conventional Group	2147	27.82 ± 3.01	27.81 ± 2.60	3247.84 ± 488.90	1.34 ± 0.72	1820 (84.69%)	66 (3.07%)
<i>t</i> or $\chi^2$		1.896	0.984	0.992	0.850	38.69	7.89
<i>P</i>		.060	.334	.321	.395	.000	.005

*T* test was conducted for statistical comparison of quantitative data, while Chi-square analysis was carried out for statistical comparison of qualitative data. BMI=body mass index.

**Table 3**  
**The scale of PFM strength of no-episiotomy women between Immersion Group and Conventional Group.**

Scale of PFM* (n)	Episiotomy	0	1	3	4	5	Z	P
Total	No	398	38	232	366	40	-3.987	.000
	Yes	2351	203	1032	110	3		
Immersion Group①	No	135	5	54	8	2	-2.024	.043
	Yes	465	42	195	15	0		
Conventional Group②	No	263	15	99	22	2	-3.368	.001
	Yes	1886	162	837	94	3		

PFM=pelvic floor muscle. Wilcoxon test was performed to evaluate the difference of PFM function between 2 groups. \*The scale of PFM strength compare with ① and ②, the *Z*-value was -0.759 and the *P*-value was .448.

**Table 4**

**the rates of SUI, vaginal wall prolapsed and uterus prolapsed between the 2 groups.**

	N	SUI (%)	Vaginal Wall Prolapsed (%)	Uterus Prolapsed (%)
Immersion Group	600	39 (6.50)	179 (29.83%)	17 (2.83%)
Conventional Group	2149	148 (6.89%)	655 (30.95%)	94 (4.37%)
$\chi^2$		0.111	0.093	2.874
P		.784	.761	.100

Chi-square analysis was carried out for statistical comparison of qualitative data.

SUI=stress urinary incontinence.

**Table 5**

**The correlation on vaginal delivery women among the scale of PFM strength, SUI, and POP.**

	N	0	1	2	3	4	5
*Scale of PFM①	2749	224	1184	1194	140	7	0
SUI②	187	21	121	44	1	0	0
POP③	869	127	603	131	8	0	0
		①-②		①-③		②-③	
r		-0.135		-0.435		0.087	
P		.000		.000		.000	

Correlation analysis was conducted using the method of Spearman.

PFM=pelvic floor muscle, POP=pelvic organ prolapsed, SUI=stress urinary incontinence.

\*① represents the scale of PFM of all the cases both in Immersion Group and Conventional Group; ② represents all the cases of SUI both in Immersion Group and Conventional Group; ③ represents all the cases of POP both in Immersion Group and Conventional Group.

**3.3. The comparison of rates of SUI, POP at postpartum 6 to 8 weeks between 2 groups**

In this study, POP includes 2 kinds of PFDs such as vaginal wall prolapsed and uterus prolapsed. Table 4 represents the rates of SUI and POP in the Immersion Group. As shown in Table 4, the rates of SUI, vaginal wall and uterus prolapsed are 6.50% (39/600), 29.83% (179/600), and 2.83% (17/600) in the water immersion group, while the rates in the Conventional Group are 6.89% (148/2149), 30.95% (655/2149), and 4.37% (94/2149), and it can be seen that there is no significant difference ( $P > .05$ ).

**3.4. The correlation among PFM strength, SUI, and POP of women at postpartum 6 to 8 weeks**

Table 5 shows that there is a negative correlation between scale of PFM strength and SUI/POP of women both in Immersion Group and Conventional Group at postpartum 6 to 8 weeks, wherein the  $r$  values are -0.135 and -0.435 ( $P < .01$ ). Moreover, there is a positive correlation between SUI and POP, with  $r$ -value of 0.087 ( $P < .01$ ).

**3.5. The scale of PFM, SUI, and POP after doing Kegel exercise at home for 6 to 8 weeks**

There were 1505 women with scale of PFM <2 grades (including 241 women with scale 0 and 1264 women with scale 1), and each of them was taught how to train their PFM at home by doing Kegel exercise for 6 to 8 weeks before coming back for accepting examine again. There were only 580 women coming back, wherein 59 women were excluded because of not doing exercise according to the guidance. After doing Kegel exercise at home, the scale of PFM was promoted, wherein the  $\chi^2$  was 170.226 ( $P < .01$ ); moreover, the rates of SUI, vaginal wall prolapsed, and uterus prolapsed were decreased, wherein the  $\chi^2$  were respectively 2.383, 2.584, 2.205 ( $P > .05$ ), with no statistical difference (Table 6).

**4. Discussion**

Pregnancy and childbirth are 2 important events in a woman's life as well as 2 independent risk factors for PFDs after delivery. The annual cost for ambulatory care of PFDs in the United States from 2005 to 2006 was almost \$300 million.<sup>[11]</sup> In China, the PFDs

**Table 6**

**The changes of SUI, vaginal wall prolapsed, uterus prolapsed, scale of PFM after PFM training.**

	Before Kegel exercise (n=521)	After Kegel exercise (n=521)	$\chi^2$	P
SUI	60 (11.52%)	45 (8.64%)	2.383	.125
Vaginal wall prolapsed	210 (40.31%)	185 (35.51%)	2.584	.110
Uterus prolapsed	41 (7.90%)	29 (7.29%)	2.205	.138
Scale of PFM			170.226	.000
0	121	80		
1	400	295		
2	0	141		
3	0	5		

PFM=pelvic floor muscle, SUI=stress urinary incontinence.

have not been attached with enough attentions. Although it is relatively rare to see a woman die from PFDs, it seriously affects the quality of women's life. Till now, the prevention, diagnosis, and treatment of women's PFDS during pregnancy and childbirth in China have not been given with sufficient attention. PFDs are prevalent both in late pregnancy and puerperium.<sup>[12]</sup> If women in postpartum period cannot persist on conservation treatment for PFDs, permanent PFDs may be probably developed.<sup>[13,14]</sup> This study showed that the scale of PFM strength was correlated with PFDs of women at postpartum 6 to 8 weeks. Hot water immersion is very common in traditional Chinese medicine. The water immersion delivery was introduced to China in 2003. Water immersion delivery is regularly carried out in our hospital, which has been gradually accepted by more and more pregnant women.

With the function of covering pelvic floor and combining with connective tissue attachments to the bony pelvis, PFM can protect the pelvic floor organizations including uterus, bladder, urethra, and rectum, and stabilize the pelvic organs in the correct position.<sup>[15]</sup> If the women's PFM are damaged during pregnancy and delivery, they will probably suffer PFDs. It has been estimated that 50% of incontinence and 75% of prolapse can be attributed to pregnancy and childbirth.<sup>[16]</sup> Siafarikas et al<sup>[17]</sup> conducted transperineal ultrasound test and found that women with major levator ani muscle defects in postpartum period had significantly smaller levator hiatus area at rest and during the Valsalva maneuver. Moreover, they had shortened levator ani muscle at mid-pregnancy and at 37 weeks of gestation. Lipschuetz et al<sup>[18]</sup> observed 198 primiparous women who had delivered their children 10 to 14 months ago using the questionnaire of PFBQ (the Pelvic Floor Symptom Bother Questionnaire) by phone and found the probability for at least 1 symptom of PFDs being reported was 64%. The results of this paper also showed that the incidences of SUI and POP at postpartum 6 to 8 weeks were negatively correlated with the scale of PFM strength, which means if a woman's PFM strength is weaker, she will have more chance to develop SUI/POP in postpartum period. For women with POP, the herniation of the pelvic organs to or beyond the vaginal walls easily causes a variety of pelvic, urinary, bowel, and sexual symptoms.<sup>[19]</sup> This study also found a positive correlation between POP and SUI. The research in the next step should pay more attention to finding the high risk group during pregnancy and postpartum period and adopting effective methods for early prevention and treatment of PFDs.

Water immersion is a nonpharmacological delivery method that has minimal impact on the fetus and the labor process.<sup>[20,21]</sup> Water immersion delivery during the first stage of labor can reduce the labor pain and decrease the use of anesthesia without increasing the rate of maternal or neonatal infections.<sup>[4,21]</sup> In this study, the water immersion delivery referred to applying water immersion during the first stage of labor and then safely moving to delivery bed during the second stage of labor. Although episiotomy is still very common in our hospital, it is avoided as much as for women accepting water immersion delivery. The occurrence rate of episiotomy in water immersion group was 77.50%, which was lower than that in the conventional labor group (84.69%). This study also found that 398 women without having episiotomy had stronger PFM than 2081 women having episiotomy at postpartum 6 to 8 weeks. At the same time, 135 women (from water immersion group) and 263 women (from tradition group) women without having episiotomy also had stronger PFM than those having episiotomy for both in water

immersion delivery and in conventional labor group. The degree of perineal damage is one of the key factors causing postpartum pelvic floor dysfunction according to earlier studies.<sup>[22]</sup> Episiotomy has been identified both as a risk and a protective factor of obstetric anal sphincter injuries. Episiotomy length and depth had positive correlation with sexual problems.<sup>[23]</sup> Women without having episiotomy in this study had intact perineum, or 1 and 2 degree of perineal damage, and stronger PFM than the women having episiotomy. The rate of episiotomy in water immersion group was lower than that in Conventional Group, however there was no difference in PFM strength and rates of SUI, POP between the 2 groups. Cortes et al<sup>[24]</sup> found that the higher proportion of nulliparas who labored in water and sustained a perineal tear was offset by a significant reduction in episiotomy. Liu et al<sup>[25]</sup> found that water immersion was associated with a lower rate of SUI at postpartum 42 days. These results also indicate that the PFM is a whole, of which the intact may be damaged by episiotomy. The PFM damage of those without having episiotomy is spontaneous perineal tear, which has less influence on the PFM. In this study, the rates of episiotomy in water immersion and Conventional Group were both very high, and there was statistical difference in the rate of episiotomy between 2 groups, while there were no significant differences in PFM strength, SUI, and POP between the 2 groups. The following clinical practice in our department is to reduce the rate of episiotomy in vaginal delivery especially in water immersion delivery and to observe the relationship between water delivery and the incidence of PFDs.

In this study, the patients with weaker strength of PFM (0 or 1 grades by modified oxford grading system) were taught to train their PFM at home by doing Kegel method for 6 to 8 weeks. After that, the strength of PFM was promoted, and the rates of SUI, vaginal wall prolapsed, and uterus prolapsed were decreased from 11.52%, 40.32%, 7.90% to 8.64%, 35.51%, 7.29%, but there were no statistical difference. These may be due to the following reasons. Firstly, the women mastered the skill of PFM contraction after training. Secondly, it was efficient to improve PFM strength through doing Kegel exercise at home during postpartum period. Lastly, it should spend more time on analyzing how to treat pelvic floor dysfunction like SUI, vaginal wall prolapsed, and uterus prolapsed, and other methods such electrical stimulation, biofeedback should be also adopted.

The limitations in this study were that the strength of PFM in postpartum 6 to 8 weeks were examined by digital palpation, but the result was not more precise than manometry, dynamometry cones, B ultrasound, and MRI. The PFM training via Kegel exercise was also too simple compared with electrical simulation, biofeedback, and so on.

## 5. Conclusions

This study suggests that water immersion during the first stage of delivery is associated with a lower rate of episiotomy but not necessarily associated with stronger PFM strength and lower SUI and POP at postpartum 6 to 8 weeks. With the popularization of water immersion delivery in China, the research focus in next step is to reduce the rate of episiotomy and to supervise PFM training during and after pregnancy. Preventing urinary incontinence, vaginal wall prolapsed, and uterus prolapsed after vaginal delivery has been a proven effective way to improve the quality of women's life, which can be realized through pelvic muscle exercise, electrical stimulation, biofeedback, and so on.<sup>[12,25]</sup>

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