Original Article

Relationship between low back pain and stress urinary incontinence at 3 months postpartum

Megumi Mutaguchi[1], Ryoko Murayama[2], Yoko Takeishi[3], Maiko Kawajiri[3], Akari Yoshida[3], Yasuka Nakamura[3], Toyoko Yoshizawa[3], Mikako Yoshida[3,*]

[1] Nursing Division, Toranomon Hospital, Tokyo, Japan;
[2] Department of Advanced Nursing Technology, Graduate School of Medicine, The University of Tokyo, Tokyo, Japan;
[3] Department of Women's Health Nursing & Midwifery, Tohoku University Graduate School of Medicine, Miyagi, Japan.

SUMMARY   Previous studies have proposed that pelvic misalignment may be associated with stress urinary incontinence through a decrease in the contractile function of the pelvic floor muscles; however, this relationship remains unclear. This study aimed to clarify the relationship between low back pain, an indication of pelvic misalignment, and stress urinary incontinence at 3 months postpartum. We conducted a cross-sectional study of women who gave birth to full-term babies between July 2008 and July 2009. Stress urinary incontinence was defined as urinary leakage when coughing, sneezing, or exercising. Low back pain was defined as pain between the ribs and gluteal sulcus in the preceding 2 months. Of the 228 subjects included in the study, the prevalence of stress urinary incontinence was 22.8% (n = 52). The prevalence of low back pain in the stress urinary incontinence group was significantly higher than that in the non-stress urinary incontinence group (78.8% [n = 41] *vs.* 57.4% [n = 101]; p = 0.005). Stress urinary incontinence was associated with older age, primiparity, vaginal delivery, and low back pain at 3 months. In conclusion, low back pain was associated with stress urinary incontinence after adjusting for pregnancy and delivery factors, suggesting pelvic misalignment contributes to the development of stress urinary incontinence. We propose that including care for pelvic misalignment in pelvic floor muscle training, the treatment of choice for stress urinary incontinence, could be beneficial.

Keywords   Low back pain, pelvic misalignment, postpartum period, urinary incontinence, vaginal delivery

1. Introduction

The prevalence of urinary incontinence (UI) in women older than 20 years is as high as approximately 25%, and approximately 80% of these women have stress urinary incontinence (SUI) (*1,2*), defined as any involuntary loss of urine on effort or physical exertion (*e.g.*, sporting activities), sneezing, or coughing (*3*). SUI impairs the affected person's quality of life (QOL) both psychologically and socially. Those affected may experience the fear of smelling like urine and of contamination of their clothes and they may restrict social activities, quit work, and experience depression (*4,5*) because SUI can occur suddenly in daily life.

The main cause of SUI is urethral closure dysfunction due to stretching of the pelvic floor fascia, ligaments, and muscles by the increasing weight of the fetus, amniotic fluid, and uterus during pregnancy (*6-8*), and defects of the pelvic floor that may occur during vaginal delivery (*9-11*). Additionally, recovery of pelvic floor function

following delivery is delayed in women who have delivered a baby for the first time at ≥ 35 years old (*12*). Thus, it is essential that patients receive appropriate treatment to promote the recovery of pelvic floor function and reduce SUI symptoms in the postpartum period.

The pelvic floor includes the muscles, fascia, and ligaments that support the pelvic organs (bladder, uterus, and intestines). It is responsible for closing the urethra and anus to prevent involuntary leakage of urine and stool, respectively. Pelvic floor muscle training is recommended to improve its supportive and urethral closure functions by strengthening the pelvic floor muscles (*13-15*), which are the main muscles of the pelvic floor. In fact, 3 months of pelvic floor muscle training in the postpartum period can restore pelvic floor function and improve SUI (*16*). However, approximately 30% of women with SUI remained symptomatic even after undergoing pelvic floor muscle training (*16*). To improve the effectiveness of treatment

in the postpartum period, an additional approach is needed to reduce SUI symptoms.

Pelvic misalignment may be a cause of decreased pelvic floor function because the pelvic floor muscles adhere to the pelvis. Increased secretion of relaxin during pregnancy alters the properties of the cartilage and tendons around the pelvis, resulting in loosening of the pubic symphysis and sacroiliac joints (*17*). In addition, the lax pelvis is exposed to the chronic load of the fetus, amniotic fluid, and uterus during late pregnancy. When this load is applied to one side of the pelvis or to an area that differs from the usual placement, the pelvis is distorted (*18,19*), and pelvic girdle pain and low back pain (LBP) occur during pregnancy and after childbirth (*20*). Considering the increased activity level of the pelvic floor muscles at rest and loss of motor control in patients with LBP (*21-23*), pelvic misalignment causes symptoms due to pelvic floor dysfunction, including SUI.

The evaluation methods for pelvic misalignment include pelvic radiography, assessment of the postural alignment when standing, and manual examination (*18-22,24*). However, these methods have the following shortcomings: radiography results in radiation exposure (*24*), and postural alignment evaluation and manual examination require special skills and a considerable amount of time (*18-22*). Thus, previous studies (*21,22*) that investigated the relationship between pelvic misalignment and SUI struggled with small sample sizes and/or no control of other pregnancy and delivery factors.

LBP mainly results from pelvic misalignment because pelvic misalignment is associated with LBP among adults (*24*) and sacroiliac joint pain among pregnant women (*25*). Thus, we propose that LBP may be useful as an alternative indication of pelvic misalignment in a large sample questionnaire study. Although a study found that many women have LBP and SUI simultaneously 12 months after childbirth (*26*), the study did not evaluate the relationship between LBP and SUI after adjusting for pregnancy and delivery factors. It remains unclear whether LBP in postpartum causes SUI independently from pelvic floor damage caused by vaginal childbirth. Therefore, this study aimed to clarify the relationship between LBP and SUI at 3 months postpartum, when SUI and LBP were likely to persist for a long period of time (*27,28*), and adjust for factors relating to pregnancy and delivery.

2. Materials and Methods

2.1. Study design, participants, and procedure

We conducted a cross-sectional study among postpartum women at an obstetrics facility in Tokyo between July 2008 and July 2009. Women who gave birth to full-term babies were recruited while they were hospitalized immediately after delivery, regardless of their SUI history. The exclusion criteria were as follows: (1) stillbirth/neonatal death, (2) neurogenic bladder dysfunction, (3) mental illness, (4) difficulty in understanding Japanese, and (5) age < 20 years old. The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the ethics committee of the institution. After obtaining consent for participating in the study, a researcher obtained the patients' demographic and obstetric data from medical records. The women answered a questionnaire regarding SUI and LBP that was delivered by mail at 3 months postpartum.

2.2. Measurements

The Japanese version of the scored International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF) (*29*) was used to evaluate the presence, degree, and type of UI. The ICIQ-SF consists of four items: frequency of UI (0-5 points), amount of urinary leakage (0-6 points), effects of UI on daily life (0-10 points), and subjective evaluation of UI symptoms (not included in the score). Higher scores indicated severe UI and a poor QOL. Women who answered that they had experienced "leakage when coughing or sneezing" or "leakage when moving or exercising" were diagnosed with SUI.

The incontinence QOL questionnaire (I-QOL) (*30*) was used to examine disease-specific QOL. The I-QOL consists of a 22-item, 5-point scale (1-5 points) that represents the effects of UI on the patient's life. The score is converted to a maximum of 100 points (range, 20-100 points). A lower score indicated that UI had a greater impact on daily living.

We also included two of our own questions that asked about whether the women experienced LBP (yes or no) and the location of the LBP in the past 2 months. Based on the definition of the LBP as published in the Japanese Orthopaedic Association guidelines (*31*), LBP was defined as pain between the lowermost rib and gluteal sulcus.

Demographic data (age, smoking history, height, weight before the current pregnancy, medical history, pregnancy history, and delivery) and information about the current pregnancy (weight gain during the pregnancy, complications, mode and duration of delivery, treatment during delivery, gestational age at delivery, birth weight, and baby's head circumference) were collected from the women's medical records.

2.3. Analysis

The Mann-Whitney *U* test, Chi-square test, or Fisher's exact test was used to compare the results of the women with and without SUI. Variables with a *p*-value of < 0.05 in the univariate analysis and the number of deliveries

considered to be theoretically essential were included in the binary logistic regression analysis. The adjusted odds ratios (AORs) and 95% confidence intervals (95% CIs) were calculated for the presence of SUI. IBM SPSS Statistics for Windows, version 23.0 (IBM Corp., Armonk, NY) was used for the analysis. A *p*-value of < 0.05 was considered statistically significant.

3. Results

Of the 286 women who participated in the study during their puerperal hospitalization, 234 responded to the questionnaire at 3 months postpartum (response rate: 81.8%). Of these women, 228 were included in the analysis after 6 women were excluded because they did not answer the questions on the subjective evaluation of their UI symptoms on the ICIQ-SF. Fifty-two women (22.8%) answered that they had SUI at 3 months postpartum. Among the 52 women with SUI, 31 experienced UI "2 to 3 times a week," followed by "about once a day" in 11 (59.6% and 21.2%, respectively; Figure 1). Forty-nine women (94.2%) had moderate urinary leakage. The I-QOL score was significantly lower in the SUI group than in the non-SUI group (90.0 ± 10.7 *vs.* 97.3 ± 8.0, *p* < 0.001).

The mean age (in years) and proportion of patients who delivered vaginally in the current pregnancy in the SUI group were significantly higher than those in the non-SUI group (*p* < 0.01, Table 1). Among the women who delivered vaginally, the duration of the second stage of labor was significantly longer in the SUI group than in the non-SUI group (98.6 ± 102.9 *vs.* 66.9 ± 95.6 minutes, *p* = 0.012). Infants born to women in the SUI group had significantly heavier birth weights than those born to women in the non-SUI group (3063 ± 403.7 *vs.* 2944 ± 338.4 g, *p* = 0.028).

The prevalence of LBP at 3 months postpartum was 142 (62.3%) in all the participants, and it was significantly higher in the SUI group than in the non-SUI group (41 [78.8%] *vs.* 101 [57.4%], *p* = 0.005; Figure 2). Logistic regression analysis showed that SUI was associated with LBP at 3 months postpartum, age, multiparity, and vaginal delivery (AOR [95% CI]: 3.60 [1.55-8.34], 1.14 [1.04-1.24], 2.39 [1.05-5.43], and 8.63 [1.07-69.68], respectively) (Table 2).

4. Discussion

This study found that the prevalence of SUI and LBP at 3 months postpartum was 22.8% and 62.3%, respectively. In addition, the study showed that LBP was associated with SUI even after adjusting for pregnancy and delivery factors.

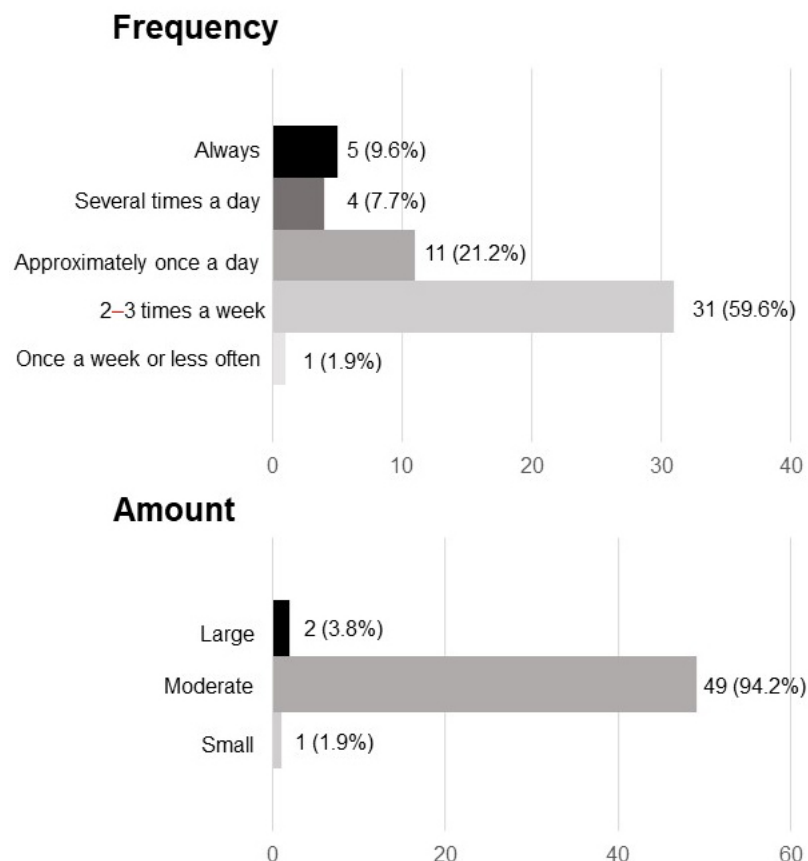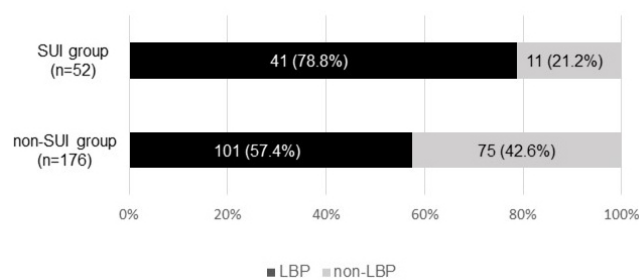The mean age in this study (35.1 and 33.7 years

Figure 1. Severity of SUI.

Table 1. Comparison of the differences in the demographic and obstetric data between the two groups

	SUI group (*n* = 52)	non-SUI group (*n* = 176)	*p*-value
Demographic data			
Age (years)	35.7 ± 4.2	33.7 ± 4.8	0.006
Smoking history			0.691
Never	47 (90.4%)	163 (92.6%)	
Past smoker	5 (9.6%)	12 (6.8%)	
Current smoker	0 (0.0%)	1 (0.6%)	
Pre-pregnancy body mass index (kg/m^2)	20.6 ± 4.1	20.7 ± 2.7	0.739
Medical history (yes)	27 (51.9%)	82 (46.6%)	0.511
Gynecological diseases	8 (15.4%)	37 (21.0%)	
Respiratory disorders	3 (5.8%)	9 (5.1%)	
Gastrointestinal disorders	5 (9.6%)	14 (8.0%)	
Orthopedic disease	6 (11.5%)	6 (3.4%)	
Urological disease	3 (5.8%)	5 (2.8%)	
Current pregnancy			
Primigravid women	29 (55.8%)	117 (66.5%)	0.157
Gestational weight gain (kg)	8.6 ± 3.4	9.2 ± 3.2	0.588
Complications (multiple answers)			0.219
Imminent preterm birth	4 (66.7%)	10 (43.5%)	
Preeclampsia	0 (0.0%)	5 (21.7%)	
Gestational diabetes	1 (16.7%)	0 (0.0%)	
Intrauterine growth retardation	1 (16.7%)	3 (13.0%)	
Imminent uterine rupture	0 (0.0%)	3 (13.0%)	
Placenta previa	0 (0.0%)	2 (8.7%)	
Delivery mode (vaginal delivery)	50 (96.2%)	124 (70.5%)	< 0.001
Total duration of labor (minutes)	388.3 ± 357.1	322.3 ± 284.1	0.294
First stage	288.4 ± 322.6	251.4 ± 241.2	0.812
Second stage	98.56 ± 102.9	66.93 ± 95.6	0.012
Treatment at delivery			
Induction	20 (39.2%)	47 (33.3%)	0.396
Epidural birth	5 (9.8%)	5 (3.5%)	0.078
Episiotomy	30 (57.7%)	76 (43.2%)	0.785
Perineal tear	22 (42.3%)	50 (40.7%)	0.762
Gestational age at delivery (days)	274.4 ± 8.0	274.1 ± 8.6	0.757
Birth weight (g)	3063.3 ± 403.7	2943.9 ± 338.4	0.028
Head circumference (cm)	33.5 ± 1.3	33.1 ± 2.9	0.227

Data are represented as the mean ± standard deviation or *n* (%), Mann-Whitney *U* test, or Fisher's exact test. Abbreviation: SUI, stress urinary incontinence.

SUI group (n=52): 41 (78.8%) LBP, 11 (21.2%) non-LBP
non-SUI group (n=176): 101 (57.4%) LBP, 75 (42.6%) non-LBP

■LBP ■non-LBP

Figure 2. Prevalence of LBP.

Table 2. SUI-related factors

Age (years)	OR	(95% CI)	*p*-value	AOR	(95% CI)	*p*-value
Birth weight (g)	1.10	(1.03-1.19)	0.009	1.14	(1.04-1.24)	0.004
LBP at 3 months	1.00	(1.00-1.00)	0.036	1.00	(0.10-1.00)	0.345
Multiparas	2.77	(1.33-5.74)	0.006	3.60	(1.55-8.34)	0.003
Second stage	1.57	(0.84-2.95)	0.159	2.39	(1.05-5.43)	0.038
(minutes)	1.00	(1.00-1.01)	0.055	1.00	(0.10-1.01)	0.129
Vaginal delivery	10.48	(2.46-44.69)	0.001	8.63	(1.07-69.68)	0.043

Abbreviations: LBP: low back pain, SUI: stress urinary incontinence, OR: odds ratio, AOR: adjusted odds ratio, 95% CI: 95% confidence interval. Logistic regression analysis. LBP at 3 months: 0 = none, 1 = yes; Multiparas: 0 = primipara, 1 = multiparas vaginal delivery: 0 = cesarean section, 1 = vaginal delivery.

in the SUI and non-SUI groups, respectively) was relatively higher than that of the average pregnant Japanese women at the time of delivery in 2018 (1st, 2nd, and 3rd child: 30.7, 32.7, and 33.7 years old, respectively) (*32*). Although the prevalence of SUI and LBP generally increases with age (*4*), in this study, the prevalence of SUI and LBP (22.8% and 62.3%, respectively) was consistent with that found among postpartum Japanese women in previous studies (SUI: 26.2% and LBP: 47.8%-71.8%) (*33-35*). Our results can be considered representative of the prevalence of SUI and LBP among general postpartum Japanese women.

This study used LBP rather than postural alignment or manual examination as an indicator of pelvic misalignment because we prioritized the conduction of a survey in a group with a large sample size. In general, the origins of LBP are divided into five categories (*31*): the spinal cord and surrounding locomotor disease, neurofibromata in the spinal cord or cauda equina, visceral organ disease (*e.g.*, renal or urinary tract stones and gynecological disease), vascular origin (aortic dissection *etc.*), and mental illness. Considering the following, we propose that most of the subjects in this study had LBP that derived from the spine: LBP of vascular origin only occurs in serious situations; the exclusion criteria for this study included neurofibromata and psychiatric disorders; all the subjects with a history of gynecological disease were undergoing treatment or had been treated; and pain related to gynecological illnesses was controlled. LBP derived from the spine is roughly divided into nervous system diseases, such as lumbar disc herniation and lumbar spinal canal stenosis, and myofascial LBP due to postural changes and pelvic misalignment. The postpartum pelvic alignment remains wider than that at 12 weeks of gestation, while postural changes during pregnancy disappear (*25*). Moreover, in this study, none of the subjects had a history of nervous system diseases such as lumbar disc herniation; thus, we concluded that the subjects' chief complaint of LBP appropriately represented pelvic misalignment.

After adjusting for pregnancy and delivery factors, we found that LBP was associated with SUI. Considering that LBP represented pelvic misalignment, our results suggest that the decrease in pelvic floor function due to pelvic misalignment is a risk factor for the development of SUI. Pool-Goudzwaard *et al.* (*21*) speculated that the insufficient contraction of the pelvic floor muscles to ensure urethral closure when the intra-abdominal pressure increases is a cause of SUI in women with LBP. This is because the pelvic floor muscles are constantly activated to eliminate the pelvic instability caused by pelvic misalignment. Complex combinations of anterior-posterior, left-right, and twisting pelvic misalignments and pelvic instability during pregnancy and delivery may be triggers for SUI through decreased pelvic floor function.

Multiparity and vaginal delivery were associated

with postpartum SUI. Considering that pelvic floor muscle abnormalities occur after vaginal delivery (*36*) and the risk of SUI increases with parity (*37*), this result confirmed that pelvic floor dysfunction due to defects in the pelvic floor muscles causes postpartum SUI.

Our findings from the I-QOL score that showed that SUI impairs the QOL of women were consistent with those of previous studies (*5,38*). Although many healthcare professionals have attempted to improve the effectiveness of pelvic floor muscle training by adding biofeedback tools, increasing the frequency and duration of training, and providing support to keep patients motivated in their training (*e.g.*, group sessions) (*15,16*), there are still some limitations to pelvic floor muscle training including a high dropout rate and moderate cure rate. As LBP coexists with SUI in many postpartum women and SUI and LBP have a strong effect on postpartum daily life (*38*), our finding of the possibility of a relationship between pelvic misalignment and SUI would provide an alternative approach to the treatment of SUI in terms of correcting pelvic misalignment.

This study had some limitations. First, it did not investigate whether subjects had any episodes of UI before the current pregnancy because we did not focus on the causal relationship between SUI and pelvic misalignment caused by the current pregnancy or delivery. Although this study included women who had pelvic misalignment or SUI regardless of their pregnancy or delivery information, this did not have an impact on the finding of a relationship between pelvic misalignment and SUI. Second, pelvic misalignment was not directly evaluated. The relationship between pelvic misalignment and decreased pelvic floor function/SUI is still under scrutiny. Nonetheless, this study revealed that LBP (pelvic misalignment) was related to postpartum SUI independent of the pelvic floor damage caused by pregnancy and delivery. Thus, we propose that further studies are required to reveal the mechanisms underlying SUI caused by pelvic misalignment. Finally, data were obtained more than 10 years ago. Although it has been a long time since the data were collected, the method that was used to determine SUI using the ICQF-SF and to evaluate LBP based on the guidelines remain the standard methods to date. In addition, in Japan, there were no differences in the delivery circumstances between the present and 10 years ago, such as the cesarean section rate (17.4% in 2005 *vs.* 20.4% in 2017) (*39*) and average maternal age at birth of the first child (29.1 years old in 2005 *vs.* 30.7 years old in 2019) (*40*). Therefore, it can be said that the results of this study fully reflect the current situation for postpartum women in Japan.

In conclusion, our results showed that the prevalence of SUI and LBP at 3 months postpartum was 22.8% and 62.3%, respectively, and the prevalence of LBP in women with SUI was as high as 78.8%. Even after

adjusting for delivery factors, it became clear that postpartum SUI was associated with LBP. This suggests that the decrease in pelvic floor function due to pelvic misalignment, which is a potential cause of LBP, is associated with the development of SUI. In future, we propose that SUI can be improved more efficiently by including correction of pelvic misalignment in conventional pelvic floor muscle training.

References

1. Hannestad YS, Rortveit G, Sandvik H, Hunskaar S; Norwegian EPINCONT study. Epidemiology of Incontinence in the County of Nord-Trøndelag. A community-based epidemiological survey of female urinary incontinence: the Norwegian EPINCONT study. Epidemiology of Incontinence in the County of Nord-Trøndelag. J Clin Epidemiol. 2000; 53:1150-1157.
2. Rortveit G, Daltveit AK, Hannestad YS, Hunskaar S. Vaginal delivery parameters and urinary incontinence: the Norwegian EPINCONT study. Am J Obstet Gynecol. 2003; 189:1268-1274.
3. Haylen BT, de Ridder D, Freeman RM, Swift SE, Berghmans B, Lee J, Monga A, Petri E, Rizk DE, Sand PK, Schaer GN. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol Urodyn. 2010; 29:4-20.
4. Fultz NH, Burgio K, Diokno AC, Kinchen KS, Obenchain R, Bump RC. Burden of stress urinary incontinence for community-dwelling women. Am J Obstet Gynecol. 2003; 189:1275-1282.
5. Nilsson M, Lalos O, Lindkvist H, Lalos A. Impact of female urinary incontinence and urgency on women's and their partners' sexual life. Neurourol Urodyn. 2011; 30:1276-1280.
6. King JK, Freeman RM. Is antenatal bladder neck mobility a risk factor for postpartum stress incontinence? Br J Obstet Gynaecol. 1998; 105:1300-1307.
7. Peschers UM, Schaer GN, DeLancey JO, Schuessler B. Levator ani function before and after childbirth. Br J Obstet Gynaecol. 1997; 104:1004-1008.
8. Dietz HP, Eldridge A, Grace M, Clarke B. Does pregnancy affect pelvic organ mobility? Aust N Z J Obstet Gynaecol. 2004; 44:517-520.
9. DeLancey JO, Kearney R, Chou Q, Speights S, Binno S. The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery. Obstet Gynecol. 2003; 101:46-53.
10. Dietz HP. Levator function before and after childbirth. Aust N Z J Obstet Gynaecol. 2004; 44: 19-23.
11. Yoshida M, Murayama R, Haruna M, Matsuzaki M, Yoshimura K, Murashima S, Kozuma S. Longitudinal comparison study of pelvic floor function between women with and without stress urinary incontinence after vaginal delivery. J Med Ultrason. 2013; 40:125-131.
12. Yoshida M, Murayama R, Nakata M, Haruna M, Matsuzaki M, Shiraishi M, Sanada, H. Pelvic floor function and advanced maternal age at first vaginal delivery. Open J Obstet Gynaecol. 2013;3: 28-34.
13. National Institute for Health and Care Excellence. NICE guideline [NG123] Urinary incontinence and pelvic organ prolapse in women: management. *https://www.nice.org.uk/guidance/ng123/chapter/Recommendations#non-surgical-management-of-urinary-incontinence* (accessed January 17, 2022).
14. Bø K, Hilde G, Stær-Jensen J, Siafarikas F, Tennfjord MK, Engh ME. Postpartum pelvic floor muscle training and pelvic organ prolapse – a randomized trial of primiparous women. Am J Obstet Gynecol. 2015; 212:38.e1-38.e387.
15. Woodley SJ, Lawrenson P, Boyle R, Cody JD, Mørkved S, Kernohan A, Hay-Smith EJC. Pelvic floor muscle training for preventing and treating urinary and faecal incontinence in antenatal and postnatal women. Cochrane Database Syst Rev. 2020; 5:CD007471.
16. Yoshida M, Murayama R, Hotta K, Higuchi Y, Sanada H. Differences in motor learning of pelvic floor muscle contraction between women with and without stress urinary incontinence: Evaluation by transabdominal ultrasonography. Neurourol Urodyn. 2017; 36:98-103.
17. Schauberger CW, Rooney BL, Goldsmith L, Shenton D, Silva PD, Schaper A. Peripheral joint laxity increases in pregnancy but does not correlate with serum relaxin levels. Am J Obstet Gynecol. 1996; 174:667-671.
18. Franklin ME, Conner-Kerr T. An analysis of posture and back pain in the first and third trimesters of pregnancy. J Orthop Sports Phys Ther. 1998; 28:133-138.
19. Morino S, Ishihara M, Umezaki F, Hatanaka H, Yamashita M, Aoyama T. Pelvic alignment changes during the perinatal period. PLoS One. 2019; 14:e0223776.
20. Sipko T, Grygier D, Barczyk K, Eliasz G. The occurrence of strain symptoms in the lumbosacral region and pelvis during pregnancy and after childbirth. J Manipulative Physiol Ther. 2010; 33:370-377.
21. Pool-Goudzwaard AL, Slieker ten Hove MC, Vierhout ME, Mulder PH, Pool JJ, Snijders CJ, Stoeckart R. Relations between pregnancy-related low back pain, pelvic floor activity and pelvic floor dysfunction. Int Urogynecol J Pelvic Floor Dysfunct. 2005; 16:468-474.
22. Eliasson K, Elfving B, Nordgren B, Mattsson E. Urinary incontinence in women with low back pain. Man Ther. 2008; 13:206-212.
23. Smith MD, Russell A, Hodges PW. Is there a relationship between parity, pregnancy, back pain and incontinence? Int Urogynecol J Pelvic Floor Dysfunct. 2008; 19:205-211.
24. Chaléat-Valayer E, Mac-Thiong JM, Paquet J, Berthonnaud E, Siani F, Roussouly P. Sagittal spino-pelvic alignment in chronic low back pain. Eur Spine J. 2011; 20 (Suppl 5):634-640.
25. Morino S, Ishihara M, Umezaki F, Hatanaka H, Aoyama T, Yamashita M. Pelvic alignment risk factors associated with sacroiliac joint pain during pregnancy. Clin Exp

Obstet Gynecol. 2018; 45:850-854.

26. Mannion CA, Vinturache AE, McDonald SW, Tough SC. The influence of back pain and urinary incontinence on daily tasks of mothers at 12 months postpartum. PLoS One. 2015; 10:e0129615.

27. Viktrup L. The risk of lower urinary tract symptoms five years after the first delivery. Neurourol Urodyn. 2002; 21:2-29.

28. Ostgaard HC. Assessment and treatment of low back pain in working pregnant women. Semin Perinatol. 1996; 20:61-69.

29. Gotoh M, Homma Y, Funahashi Y, Matsukawa Y, Kato M. Psychometric validation of the Japanese version of the International Consultation on Incontinence Questionnaire-Short Form. Int J Urol. 2009; 16:303-306.

30. Homma Y, Ando T, Yoshida M, Takei M, Gotoh M, Ohkawa A, Kageyama S. Validation of the Japanese version of QOL questionnaires for urinary incontinence. Journal of Japan Neurogenic Bladder Society. 2002; 13:247-257. (in Japanese)

31. The Japanese Orthopaedic Association & Japanese Society of Lumbar Spine Disorders. Guideline for low back pain. *https://minds.jcqhc.or.jp/docs/gl_pdf/G0001110/4/Low_back_pain.pdf* (accessed January 17, 2022) (in Japanese)

32. Cabinet Office, Government of Japan. A 2018 Declining Birthrate White Paper (Summary). *https://www8.cao.go.jp/shoushi/shoushika/whitepaper/measures/english/w-2018/pdf/part1-1.pdf* (accessed January 17, 2022). (in Japanese)

33. Takaoka, T. Examination of the relationship between the prevalence of postpartum urinary incontinence and factors during labor-Comparison between spontaneous delivery and delivery with medical intervention. J Jpn Acad Midwif. 2013; 27:29-39. (in Japanese)

34. Kusumi Y, Kano N, Komatsu M. Daily changes in low back pain during the puerperium and related factors. J Jpn Acad Midwif. 2007: 21;36-45. (in Japanese)

35. Nagami, T. Physical symptoms of postpartum women - from a questionnaire survey of women raising children. J Jpn Health Sci. 2019; 22:16-21. (in Japanese)

36. DeLancey JO, Kearney R, Chou Q, Speights S, Binno S. The appearance of levator ani muscle abnormalities in magnetic resonance images after vaginal delivery. Obstet Gynecol. 2003;10:46-53.

37. Rortveit G, Daltveit AK, Hannestad YS, Hunskaar S. Norwegian EPINCONT Study. Urinary incontinence after vaginal delivery or cesarean section. N Engl J Med. 2003; 348:900-907.

38. Mannion CA, Vinturache AE, McDonald SW, Tough SC. The influence of back pain and urinary incontinence on daily tasks of mothers at 12 months postpartum. PLoS One. 2015; 10:e0129615.

39. Ministry of Health, Labour and Welfare of Japan. Overview of Medical Facility Survey and Hospital Report. *https://www.mhlw.go.jp/toukei/saikin/hw/iryosd/17/dl/09gaikyo29.pdf* (accessed January 17, 2022). (in Japanese)

40. Ministry of Health, Labour and Welfare of Japan. Overview of Demographic Statistics in 2019. *https://www.mhlw.go.jp/toukei/saikin/hw/jinkou/geppo/nengai19/dl/gaikyouR1.pdf* (accessed January 17, 2022). (in Japanese)

*Address correspondence to:
Mikako Yoshida, Department of Women's Health Nursing & Midwifery, Tohoku University Graduate School of Medicine, 2-1 Seiryo-machi, Aoba-ku, Sendai, Miyagi, 980-8575, Japan.
E-mail: mikako.yoshida.e2@tohoku.ac.jp