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Review Article

Altered musculoskeletal mechanics as risk factors for postpartum pelvic girdle pain: a literature review

Asuka Sakamoto, PhD[1, 2], Kazuyoshi Gamada, PhD[1)*]

[1)] *Graduated School of Medical Technology and Health Welfare Sciences, Hiroshima International University: 555-36 Kurosegakuendai, Higashihirsoshima-shi, Hiroshima 739-2631, Japan*
[2)] *Faculty of Rehabilitation Sciences, Nishikyushu University, Japan*

Abstract. [Purpose] The aim of this literature review was to detect the factors associated with pelvic girdle pain persisting for over 3 months in the postpartum period. [Methods] We performed a broad literature search for eligible studies published before May 1, 2018 using electronic databases and processed the data using a review process. [Results] In the initial online search, we identified 12,174 potential studies. Finally, 22 studies met the specified criteria and were included for examination of risk factors for persistent pelvic girdle pain after delivery. Pain intensity and disability during pregnancy were risk factors for pelvic girdle pain persisting for over 6 months after delivery. The active straight leg raising test predicted the risk of persistent pelvic girdle pain after delivery. Dysfunction of the pelvic floor muscles was also a risk factor for persistent pelvic girdle pain. [Conclusion] Pain intensity and disability during pregnancy, positive provocation tests, active straight leg raising test, and musculoskeletal mechanics were positively associated with pelvic girdle pain persisting for over 3 months after delivery.
Key words: Postpartum women, Persistent pelvic girdle pain, Risk factors

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INTRODUCTION

The prevention of persistent lower back pain (LBP) and pelvic girdle pain (PGP) lasting more than 3 months after childbirth requires a thorough understanding of the associated risk factors. The etiology of pregnancy-related PGP has been investigated for decades and the causes and risk factors have been discussed from several perspectives. Some of the reported risk factors include age, history of PGP, LBP before pregnancy, parity, body mass index (BMI), smoking, and psychological factors[1)]. However, Kovacs et al.[2)] found that smoking, weight, height, and age were not associated with persistent PGP in the postpartum period. Although individual factors have been described as potential causes of PGP, these have not yet been adequately clarified in the literature. Thus, classifying the level of evidence for risk factors or predictors of persistent PGP in postpartum women may contribute to elucidating this issue.

The combination of mechanical and hormonal changes experienced during pregnancy is often cited as a possible cause of PGP. However, persistent PGP in the postpartum period may not be associated with those mechanical and hormonal changes since they only affect PGP during pregnancy; after delivery, hormonal levels return to normal. Bjelland et al.[3)] suggested that the presence of emotional distress during pregnancy was independently associated with the persistence of PGP after delivery. Although emotional aspects are considered as a risk factor for persistent PGP, there is no doubt that the sacroiliac joint can be a source of LBP or pelvic pain and the theory that PGP can be caused by pelvic instability has been supported by several studies[4–6)]. Pelvic instability refers to a failure of the pelvic load transfer mechanism due to excessive pelvic joint movement. Indeed, pelvic load transfer is supported by well-coordinated neuromuscular and articular systems known as the form- and

*Corresponding author. Kazuyoshi Gamada (E-mail: kazgamada@ortho-pt.com)

force-closure model of these joints[6]. Thus, bony and muscular mechanisms directly influence the prognosis of PGP more than emotional and other factors. However, the causes and risk factors of long-term persistent PGP in the postpartum period remain unknown. The aim of this literature review is to clarify factors associated with PGP persisting for more than 3 months in the postpartum period.

METHODS

Guidelines on preferred reporting items for reviews were followed when conducting this literature review[7]. We performed a broad search for eligible studies published before May 1, 2018 using the following electronic databases; PubMed, Medline, Pedro, Sage Journal, Google Scholar, and the Cochrane Library. The literature search was carried out to identify all available published articles on the relation and/or association between each keyword. Comprehensive combinations of key words including ['pelvic girdle pain' or 'pelvic pain'], ['risk factors', 'predictor' or 'causes'], and ['postpartum women', 'postnatal women', 'after delivery' or 'childbirth'] were utilized to search for potential studies. Data extraction from selected studies followed the guidelines[7]. The principal author scanned the reference lists of retrieved articles at the first data selection and two authors (the principal author and corresponding author) discussed each article and confirmed it.

Articles reviewed were published or available online between 1998 and April 30, 2018. The following eligibility criteria were applied to the papers to ensure the studies used were relevant: (1) the articles were written in English; (2) publication type was prognostic study, longitudinal study, or prospective cohort study; (3) study population consisted of women experiencing PGP in the postpartum period or pregnancy and postpartum period; and (4) outcomes included risk factors, predictive factors, or prognostic factors for persistent PGP in the postpartum period. Exclusion criteria were as follows: (1) publication type was a tutorial review, anecdotal report, abstract form, systematic review, or case report; (2) study population was a mixed sample comprised of women with PGP and LBP or women with LBP only; (3) study period was only during pregnancy; and (4) other symptoms such as incontinence, diastasis recti abdominis, fracture, or pelvic fusion were examined. For data collection, the titles and abstracts were initially screened for potentially relevant studies. Each article was identified based on the relevance of the study in relation to the eligibility criteria and the study aim. Duplicate articles were excluded. Study design, year of the study, sample size population, gestational period of the population, type of assessments, statistical analysis, main findings and conclusion were extracted.

RESULTS

The initial online search identified 12,174 potential studies. Finally, 22 studies met the specified criteria. A flow diagram of the search process is presented in Fig. 1. All 22 studies were longitudinal, prospective cohort studies, cross-sectional studies, or case studies[8–29]. The sample sizes ranged from 36[20] to 10,603[3]. All studies investigated risk factors for persistent PGP in the postpartum period lasting from 3 months to 12 years after delivery.

The primary outcome measures used in these studies was a questionnaire regarding the disability level. The pain intensity was measured using either a numerical rating scale (NRS) or visual analog scale (VAS). PGP was assessed with sacroiliac joint provocation tests, the active straight leg raising (ASLR) test, and/or symphysis pubis palpation. The association between PGP and other factors was examined utilizing questionnaires, ultrasound, gait analysis, electromyography (EMG), and Doppler imaging of vibrations.

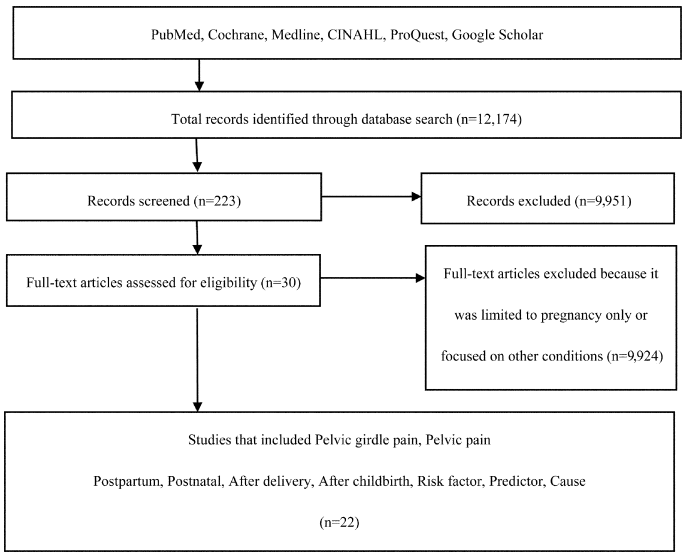

Fig. 1. Flow chart of the study selection process.

A total of six articles described risk factors for postpartum PGP for 12 weeks to 1 year after delivery[8–12, 17] (Table 1). Pain locations in the pelvis and responses to clinical tests in late pregnancy influenced the clinical course of physical functioning and bodily pain in the postpartum period (correlation between pain intensity and disability r=0.708, p<0.001)[11]. Six studies identified three risk factors for persistent PGP in the postpartum period (Table 2)[8, 10, 11]. Marital status, education, smoking, pre-pregnancy physical activity, and the Hopkins Symptom Check List-25 (HSCL-25) were not significantly associated with either the disability rating index (DRI) or pain intensity at 12 weeks postpartum in the bivariate analysis (0.56<p<0.81)[8]. Evening pain and Oswestry disability index (ODI) scores at 12 months after delivery were associated with a patient's belief in the possibility of pain improvement[12].

Four articles reported prognostic factors for long-term persistent PGP after delivery and conducted follow-up studies for 1–2 years after delivery[12, 14–16] (Table 2). Positive symphysis pressure test (OR: 2.01), positive FABER test (OR: 2.22), positive modified Trendelenburg test (OR: 2.20), and a high number of bilateral positive pain provocation tests (OR: 1.79) were predictors for long-term persistent PGP[16]. ASLR test was reported to be a predictor of persistent PGP after delivery. An ASLR score of at least 4 predicted an ODI score ≥10 at 1 year postpartum or a pain score ≥8.0 compared to that of women with an ASLR score <4. The number of pain locations was also reported to be an important predictor of recovery; the prevalence of PGP 2 years after delivery was <10% and 21% for women experiencing pain in one or two joint regions and those experiencing pain in all three joints, respectively[12–14].

Seven articles described musculoskeletal factors related to persistent PGP in the postpartum period (Table 3)[15, 20–26]. Compared to the resting value of transverse abdominal thickness (TrA), women with PGP showed increased TrA of 31% (standard deviation (SD) 46%) and 31% (SD 57%) during ipsilateral and contralateral ASLR, respectively. In the control group, these values were 11% (SD 25%) and 13% (SD 22%)[21]. Trunk flexor endurance and disability as well as hip extensor strength were associated with long-term disability at 15 months postpartum[15]. BMI and levator hiatus area were 12.42

Table 1. Studies examining risk of low back pain (LBP) or pelvic girdle pain (PGP) associated with pain intensity and questionnaires during pregnancy

Study	Design	Participants	Risk factors	Outcome	
				Pain intensity (OR [95%CI], p value)	Questionnaires (OR [95%CI], p value)
Vøllestad, N.K. et al., 2009	Longitudinal observational study	Women with PGP during pregnancy or within 3 weeks after pregnancy (n=78)	Evening pain, ODI	Number of pain locations: (8.0, [−0.03, 16], p=0.05)	Belief improvement (3.9 [1.5, 10.4], p=0.006)
Robinson, H.S. et al., 2010	Prospective cohort study	Pregnant women at GW 30 (n=283), experiencing PGP (n=179)	DRI and pain intensity in GW 30	Symphysis pain only (11.8 [2.3, 21.2], p= 0.03) Posterior pain only (3.4 [−1.0, 7.8], p=0.03) Combined symphysis pain and posterior pain (8.4 [−0.07, 17.0], p=0.03)	DRI (0.5 [0.3, 0.6], p<0.001)
Gutke, A. et al., 2011	Prospective cohort study	Pregnant women at 12 and 18 GW and 3 months after delivery (n=457)	Pain intensity HRQL in 12 and 18 GW	Pain intensity VAS score (0.419 [0.117, 0.346], p=0.000)	EQ-5D score (0.49 [4.546, 3.462], p=0.012) TSK score (0.534 [0.032–0.665], p=0.032)
Robinson, H.S. et al., 2014	Prospective cohort study	Pregnant women (n=215)	Pain in GW 30	Pain locations (symphysis and bilateral SI joints) in GW 30 contributed to PGP 12 months after delivery (OR not provided)	
Gausel, A.M. et al., 2016	Prospective cohort study	Women within 1 day after delivery (n=569), women 3–6 months after delivery (n=550)	ODI in pregnancy, combined PGP and LBP during pregnancy	High combined PGP and LBP during pregnancy (2.8 [1.2, 6.4], p=0.017)	ODI in pregnancy (ODI>20: 3.3 [1.1–9.7], p=0.034) ODI>40: 5.1 [1.7–15.0], p=0.003)
Bergström, C. et al., 2017	Long-term follow-up study based on a previous cohort study	Postpartum women 12 months after delivery (n=639)	Duration and/or persistence of pain	Women with PGP for >30 days during the past 12 months were 23 times more likely to experience persistent pain than women reporting <30 days of pain. Pain duration ≥30 days (23.5 [11.03, 50.32], p<0.0001)	

GW: gestation week; OR: odds ratio; RR: relative risk; ODI: Oswestry disability index; DRI: disability rating index; HRQL: health rerated quality of life; EQ-5D: EuroQol 5 Dimension.

Table 2. Studies examining risk of low back pain (LBP) or pelvic girdle pain (PGP) associated with provocation tests and active straight leg rising (ASLR) test during pregnancy

Study	Design	Participants	Factors	Outcome (OR) (OR [95%CI], p value)
Albert, H. et al., 2001	Longitudinal cohort study (from 30 GW to 2 years after delivery)	Pregnant women enrolled at 30 GW (n=1,789)	A high number of positive provocation tests and a low mobility index at 30 GW	Risk of having PGP at 2 years after delivery. Number of positive objective pain tests ≥16 of 20 points, OR: 19.0
Vøllestad, N.K. et al., 2009	Longitudinal study	Women with PGP pregnancy or within 3 weeks after pregnancy (n=78)	ASLR score	Prediction of reduction of PGP at 3 months. ASLR score: score 4–10: OR: 1.0 score 0–3: (4.4 [1.1, 17.5], p=0.035)
Sjödahl, J. et al., 2013	Longitudinal follow-up study	Postpartum women with PGP or PGP + LBP within 3 months after delivery (n=88)	ASLR test	ASLR test was not found to be a significant predictor of long-term disability at 15 months postpartum. (neither OR nor RR provided)
Elden, H. et al., 2016	Longitudinal follow-up study	Pregnancy with PGQ (n=371), pregnancy without PGP (n=290)	A high number of positive provocation tests, positive symphysis pressure test, modified Trendelenburg, or Patrick's test were predictors	Positive symphysis pressure test (OR: 2.01), positive FABER test (OR: 2.22), positive modified Trendelenburg test (OR=2.20), a high number of bilateral positive pain provocation tests (OR: 1.79) were predictors for long-term PGP. High number of bilateral positive pain provocation tests (1.79 [1.25, 2.57], p=0.0015)

GW: gestation week; OR: odds ratio; RR: relative risk; PGQ: pelvic girdle questionnaire.

(2.72) cm^2 and 13.67 (2.8) cm^2 for the PGP and control groups (p=0.015), respectively[22]. Regarding the electromyographic activities of the pelvic floor muscles (PFM), the levator hiatus showed 10.30 (2.67) and 11.50 (0.2.55) for the PGP and control groups (p=0.026), respectively[22]. The PGP group showed a delayed onset in both the PFM (p=0.01) and muscles of the lower lateral abdominal wall (p<0.01) compared with the control group[23]. Patients with moderate to severe PGP who demonstrated asymmetric laxity of the sacroiliac joints (SIJ) on Doppler examination during pregnancy had a three-fold higher risk of moderate to severe postpartum PGP than patients demonstrating symmetric laxity[24]. Women experiencing PGP or a combination of PGP and LBP after delivery showed low endurance of trunk flexors during early pregnancy[25].

Eight articles described factors that predicted PGP persisting for 3 months to 11 years after delivery[10, 13, 15, 16, 18, 19, 27, 29] (Table 4). In women who underwent caesarean delivery, predictors of pain at 2 weeks and 3 months postpartum were associated with increased pain at 2 weeks postpartum compared to that of women who underwent vaginal delivery (χ^2=17.39, p<0.001), while at 3 months, there was no significant difference in the incidence of pain between the two groups. Women with pre-existing pain were more likely to experience pain at 2 weeks postpartum (χ^2=7.50, p=0.006) and patients with pain at 2 weeks postpartum were more likely to experience pain at 3 months postpartum (χ^2=7.74; p=0.005)[18].

Four studies investigated risk factors for postpartum PGP and found no associations. Items showing no association with PGP at 2, 6, and 11 years after pregnancy were the total number of pregnancies, number of children, birth weight, and gender of the last born baby[16]. Breastfeeding patterns at 5 months after delivery were not associated with persistence of PGP[19]. Sitting position during breastfeeding was not associated with persistent postpartum PGP (OR: 1.5, 95% CI: 0.9–2.8)[26]. Additionally, age alone was not significantly associated with any of the response variables (0.31<p<0.88)[15]. History of LBP and emotional distress did not show any predictive power[12]. Therefore, factors such as mode of delivery, breastfeeding, age, and history of LBP remain controversial.

DISCUSSION

The aim of this literature review was to clarify factors associated with persistent PGP lasting for more than 3 months in the postpartum period. Twenty-two studies met the inclusion criteria; six studies[8–12, 17] focused on pain intensity and disability during pregnancy as risk factors examined by questionnaire surveys; four studies[12, 14–16] utilized provocation tests and the active straight leg rising (ASLR) test; seven studies[15, 21–26] examined musculoskeletal factors; and eight studies[13, 15, 16, 18, 19, 23, 26, 27, 29] focused on other aspects in order to identify risk factors for persistent PGP. Pain intensity and disability during pregnancy were risk factors of persistent PGP more than 6 months after delivery[10, 17]. In addition, the ASLR test predicted the risk of persistent PGP after delivery[12, 15]. Dysfunction of the pelvic floor muscles was also considered a risk factor for persistent PGP[23]. Other factors, such as history of pain, type of feeding or delivery, and maternal age showed inconsistent results in our review[12, 26].

Table 3. Studies examining risk of low back pain (LBP) or pelvic girdle pain (PGP) associated with musculoskeletal factors during pregnancy

Study	Designed	Participants	Factors	Outcome (OR [95% CI], p value)
Damen, L. et al., 2002	Prospective cohort study	Pregnant women in 36th week of gestation (n=123)	Asymmetric SIJ laxity	Psymmetry laxity OR: 3.1
Gutke, A. et al., 2008	Cohort study	Pregnant women (n=308)	Low endurance of back flexors, older age, combined pain in early pregnancy and work dissatisfaction	(neither OR nor RR provided)
Stuge, B. et al., 2012	Cross-sectional study	Women during pregnancy or within three weeks after delivery with PGP (n=49), control (n=49)	Size of the levator hiatus area, pelvic floor muscle strength, BMI	Pelvic floor muscle strength (cmH_2O) Strong (>40.2) Reference Medium (23.7–40.2) (0.48 [0.14, 1.65], p<0.001) Weak (<23.7) (0.63 [0.20, 1.984], p<0.001) Pelvic floor muscle endurance (cmH_2Os) Good (>314) Reference Medium (175–314) (0.93 [0.30, 2.85], p<0.001).) Poor (<175) OR: 0.32 (0.07, 1.37) Vaginal resting pressure (cmH_2O) High (>40.4) Reference Medium (28.8–40.4) (0.37 [0.10, 1.35], p<0.001) Low (<28.8) (0.67 [2.23, 1.98], p<0.001) Levator hiatus area at rest (cm^2) Small (>11.6) Reference Medium (11.6–14.0) (0.78 [0.20, 3.15], p<0.001) Large (<14.0) (0.08 [0.1, 0.57], p<0.001)
Sjödahl, J. et al., 2013	Longitudinal follow-up study	Postpartum women with PGP or PGP + LBP within 3 months after delivery. (n=88)	Trunk flexor endurance, hip extensor strength	Trunk flexor endurance (1.23 [0.62, 1.83] , p=0.0002), Hip extensor strength (0.05 [0.01, 0.11], p=0.0885)
Mukkannavar, P. et al., 2014	Cross-sectional study	Postpartum women (n=284)	Caesarean delivery, ASLR test score, Unilateral P4 test, Sitting position during feeding	Caesarean delivery (2.0 [1.3, 4.9]), ASLR test score >4 (2.3 [1.2, 3.3]), Unilateral P4 test (1.8 [1.1, 3.0]), Sitting position during breastfeeding (1.5 [0.9, 2.8])
Sjödahl, J. et al., 2016	Cross-sectional study	Women with PGP (n=16), vs. women without PGP (n=11)	PFM	Later onset time in PFM and muscles of the lower lateral abdominal wall (neither OR nor RR provided)
Mens, J.M. et al., 2017	Cross sectional observational study	Postpartum women with PGP (n=43) vs. postpartum women without PGP (n=36)	Thickness of TrA during ASLR (measured by ultrasound)	Excessive contraction of TrA during ASLR (neither OR nor RR provided) Compared between PGP and no PGP in postpartum period

GW: gestation week; OR: odds ratio; RR: relative risk; TrA: transverse abdominis; BMI: body mass index; P4 test: posterior pelvic pain provocation test; ASLR test: active straight leg rising test.

Pain intensity and disability during[12–30)] gestation weeks were associated with persistent PGP more than 3 months after delivery[1, 9–12, 17)]. Three studies found that the number of pain locations was related to persistent PGP in the postpartum period[1, 9, 12)]. Combined symphysis and posterior pain were more likely to cause PGP lasting for more than 3 months after delivery than a single pain location[1)]. Additionally, Gutke et al.[11)] found that severe pain intensity (VAS >30 mm) during pregnancy was associated with persistent PGP 3 months after delivery. Bergström et al.[17)] showed that patients experiencing pain lasting more than 30 days after delivery were 23 times more likely to have persistent pain than those experiencing pain for less than 30 days. In terms of disability, ODI, DRI, and health rerated quality of life (HRQL) were utilized to examine the risk factors for persistent PGP. Gausel et al.[10)] found that an ODI score more than 20 during pregnancy was associated with persistent PGP and a high disability level 3 months after delivery. Therefore, examining the pain intensity and disability level could predict the risk of persistent PGP after delivery.

Either the ASLR test or provocation tests were commonly utilized in most studies associating PGP with altered mechanics and motor control of the pelvis. The ASLR test is a functional pelvic assessment tool, recognized to be reliable for assessing the quality of load transfer from trunk to leg. The ASLR score was utilized as a predictor of persistent PGP after delivery[12, 15)]. Vøllestad et al.[12)] found that an ASLR score of four or above was associated with reduced PGP 3 months after delivery. However, Sjödahl et al.[15)] showed that the ASLR score was not a significant predictor of long-term disability at 15 months

Table 4. Studies examining risk of low back pain (LBP) or pelvic girdle pain (PGP) associated with feeding, delivery, history, or age

Study	Design	Participants	Predictive factors	Outcome (OR [95%CI], p value)
Bastiaanssen, J.M. et al., 2005	Longitudinal observation study	Pregnant women (n=7,526)	History of LBP/PGP	(OR nor RR provided)
Mukkannavar, P. et al., 2012	Cross-sectional study	Postpartum women (n=234)	History of LBP before pregnancy mode of delivery	LBP before pregnancy (1.7 [1.4, 2.6], p=0.001). Mode of delivery, caesarean delivery had significantly higher prevalence of PGP (33%) to compare with vaginal delivery (8.3%)
Stomp-van den Berg, S.G. et al., 2012	Cohort study and RCT	Pregnant women (n=548)	History of LBP, sleep time, posture	(OR nor RR provided)
Sjödahl, J. et al., 2013	Longitudinal observation study	Postpartum women with PGP or PGP + LBP within 3 months after delivery (n=88)	Age at pregnancy, trunk flexor endurance, disability, hip extensor	Age and trunk flexor endurance age >30 (2.5 [1.4, 3.6], p=0.042)
Bjelland, E.K. et al., 2013	Longitudinal observation study	Women with singleton delivery with PGP (n=10,603)	Type of feeding	Breast feeding (1.17 [0.91–1.50], p>0.05) Bottle feeding (1.13 [0.96–1.33], p=0.01)
Gausel, A.M. et al., 2016	Prospective cohort study	Women within 1 day after delivery (n=569), women at 3–6 months later (n=550)	Age >30 years after delivery	Age >30 years (2.9 [1.3, 6.8], p=0.012)
Elden, H. et al., 2016	Longitudinal observation study	Pregnancy with PGQ (n=371) and pregnancy without PGP (n=290)	History of LBP before pregnancy	History of LBP (2.28 [1.12, 4.66], p=0.02)
Munro, A. et al., 2017	Longitudinal observation study	Pregnant women (n=254)	Mode of delivery	Predictors of pain at 2 weeks: caesarean delivery and pre-existing pain (X^2 [1, N=133]=17.39; p<0.001). (OR nor RR provided)

GW: gestation week; OR: odds ratio; RR: relative risk; PGQ: pelvic girdle questionnaire.

postpartum. Long-term disability, such as more than 12 months, might be difficult to predict by the ASLR score alone. In terms of provocation tests, a high number of positive provocation tests was a predictor of persistent PGP. According to Albert et al.[14], a high number of positive pelvic joint provocation tests (more than 16 of 20 tests, OR: 19.0) was identified as indicating the greatest relative risk of long-term PGP. More than three different provocation tests should be used since the reliability of each provocation test is low[30]. Thus, the ASLR test and a combination of several different provocation tests would be useful to predict persistent PGP in the postpartum period.

Musculoskeletal factors related to PGP involving the pelvic joints and musculoskeletal structures were identified as the main risk factors. The SIJ and pubic symphysis are the source of pelvic instability and pelvic girdle pain[5]. Although mobility of the pelvic joints in patients with PGP is considered to cause pain in the SIJ and/or pubic symphysis and degrade the normal load transfer function of the pelvic ring, reliable scientific evidence for this is lacking. Pelvic asymmetry has been noted as a cause of SIJ pain[31]. Asymmetrical pelvic alignment increases the tightness of the ligaments and muscles around the SIJ, and stress applied to the asymmetrical SIJ easily induces pain[32]. Damen et al.[24] found that the mean SIJ laxity in the PGP group was not significantly different from that of the group without PGP upon Doppler examination. However, the mean left-right difference was significantly higher in the PGP group (2.2 threshold unit (TU)) than that in the group without PGP (0.9 TU). A comparison of subjects with PGP with asymmetric or symmetric laxity of the SIJ showed significant differences in the mean VAS for pain (7.9 vs. 7.0, respectively), positive provocation test (59% vs. 35%, respectively), positive ASLR test (85% vs. 41%, respectively), and mean Quebec Back Pain Disability Scale (QBPDS) score (8.1 ± 1.5 vs. 62.4 ± 15.3, respectively)[24]. Thus, asymmetric laxity of pelvic joint ligaments is associated with long-term persistent PGP.

Function of the pelvic floor muscles is one of the factors contributing to persistent PGP after delivery[4]. Although the pelvic floor muscles are likely to be injured during delivery, there is no strong evidence of an association between PGP and pelvic floor muscle injury. It is generally known that the pelvic ligament loosens due to hormonal effects during pregnancy causing laxity of the pelvis, while the enlarged abdomen simultaneously increases lumbar spine lordosis as well as the burden on the lumbo-pelvic girdle. Two studies in our review showed that the size and function of the pelvic floor muscles were associated with persistent PGP after delivery[22, 23]. Stuge et al.[22] and Sjödahl et al.[23] found that the size of the levator hiatus area in women with PGP was smaller than that in women without PGP, and the onset of electromyographic activities in the

pelvic floor muscles of women with PGP was delayed compared with that in the control group. Pelvic floor muscle function may be related to persistent PGP after delivery. It is well known that proper muscle activation integrated with an intact articular system is required to maintain an appropriate pelvic load transfer mechanism[31, 33]. However, it remains unclear how passive and active musculoskeletal structures cooperatively interact to achieve pelvic joint stability during recovery from persistent PGP. Thus, further study is needed to identify the association between musculoskeletal factors and persistent postpartum PGP.

History of LBP is considered a predictor of persistent PGP after delivery[13, 16, 27, 29]. However, one of the studies in our review found that a history of LBP was not significantly associated with persistent PGP after delivery[15]. Although hormonal interactions due to breastfeeding were predicted to be a risk factor for persistent postnatal PGP, our review found that breastfeeding was not related to PGP 5 months after delivery[19]. Compared with vaginal delivery, caesarean delivery was more likely to cause persistent postnatal PGP[18]. Therefore, history of LBP and breastfeeding remain controversial as risk factors for persistent PGP.

One limitation of this study was the lack of level 1 evidence to determine the risk factors for persistent PGP after delivery. Therefore, only studies at level 2 or lower were included, which prevented us from performing meta-analyses. The second limitation was that many studies may have involved recall bias during data acquisition of pain history. Further studies are needed to clarify the causes and risk factors of persistent PGP.

Our review included 22 studies examining the risk factors for persistent PGP after delivery. They reported a positive association between persistent PGP more than 3 months after delivery and pain intensity as well as disability during pregnancy, positive provocation tests, ASLR test, musculoskeletal mechanics, and the type of delivery. This review study can help for health care providers to consider the persistent PGP risks after the delivery during pregnancy. Additionally, the study suggested that to assess ASLR test, provocation test and musculoskeletal mechanics during pregnancy can be useful tools to predict the persistent PGP after delivery. Further studies should be needed to establish strong evidence identifying the causes and risk factors of persistent postnatal PGP.

Conflict of interest

None.

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