Journal of
Gynecology and Women's Health
ISSN 2474-7602

Research Article
Volume 21 Issue 5 - July 2021
DOI: 10.19080/JGWH.2021.21.556074

J Gynecol Women's Health

Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review

Asuka Sakamoto[1]*, Akino Aoki[2], Tsuyoshi Morito[3] and Kazuyoshi Gamada[4]

[1]*Faculty of Rehabilitation Sciences, Nishikyushu University, Japan*

[2]*School of Health Sciences, Kawahara International University of Health and Welfare, Japan*

[3]*School of Sport Sciences, Waseda University, Japan*

[4]*GLAB, CO. LT. 889-1 Munechikayanagikoku, Kurose-cho, Higashihiroshima-shi, Japan*

Submission: June 30, 2021; **Published:** July 09, 2021

***Corresponding author:** Asuka Sakamoto, Faculty of Rehabilitation Sciences, Nishikyushu University, Japan

Abstract

This review systematically examined features of changes in pelvic alignment during pregnancy and postpartum recovery, and clarified the relationship between changes in pelvic alignment or posture and LBP or PGP.

Method: A literature search was performed to identify all published articles focusing on the association between posture, pelvic alignment, and LBP or PGP during pregnancy and the postpartum period. Observational, longitudinal, cross-sectional, or case studies that focused on changes in pelvic alignment or posture in pregnancy and postpartum recovery, as well as relationships between those changes and LBP or PGP were included. Study selection was conducted by three reviewers. Overall risks of bias of each article were examined using the RoBANS.

Results: 1,974 studies were identified, but only 18 articles met the criteria for inclusion in this review. Ages ranged from 18 to 48. Most studies had little risk of bias, according to RoBANS. These studies investigated how changes or the lack of change in posture and pelvic alignment related to LBP or PGP.

Conclusion: Changes in pelvic alignment and posture during pregnancy may persist into the postpartum period. It was not possible to conclude that changes in posture and pelvic alignment are related to LBP or PGP, as many of the studies we reviewed included small sample sizes, and some studies used methods of low reliability. Thus, further study employing greater methodological stringency is required to resolve these questions.

Keywords: Changes in pelvic alignment; Changes in posture; Pregnancy; Postpartum; Low back pain; Pelvic girdle pain

Abbreviations: LBP: Lower Back Pain; PGP: Pelvic Girdle Pain; BMI : Body Mass Index; SI Joint: Sacroiliac Joint; Robans: Non-Randomized Studies; ASIS: Anterior Superior Iliac Spine; PSIS: Posterior Superior Iliac Spine; CT: Computed Tomography; MRI: Magnetic Resonance Imaging; 3D: Three-Dimensional; PS: Pubic Symphysis; AP: Antero-Posterior

Introduction

Lower back pain (LBP) and pelvic girdle pain (PGP) are primary adverse consequences of pregnancy. Over 50% of pregnant women suffer pain and ~30% of those complained that PGP persisted >3 months after childbirth [1-3]. Risk factors included history of LBP, previous PGP, trauma of the pelvis, and increased body mass index (BMI) [4,5]. According to Spice et al. [6], persistent PGP for 3 months after delivery was associated with increased disability scores, positive pain provocation tests, increased symphyseal distention, asymmetric laxity of SI joints, and hypermobility. Increased intra-abdominal pressure is also related to PGP [7]. Changing posture and excess abdominal area are natural occurrences in pregnancy [8]. Those changes potentially cause LBP and PGP. Thus, accurate measurements of pelvic alignment and posture related to LBP or PGP are crucial to manage persistent pain.

Excessive lordosis and sacroiliac joint mobility have been identified as possible sources of LBP and PGP. As pregnancy progresses, abdominal distension, and the load imposed upon the spine and pelvis by the gravid uterus increase considerably [9,10]. The uterus shifts forward, changing the center of gravity and orientation of the pelvis [9,10]. Lumbar lordosis may also be increased. Several studies have reported an association between pelvic alignment and PGP [4,11], specifically laxity of ligaments around sacroiliac joints and resulting dysfunctions occurring during pregnancy [12]. According to Aldabe et al. [13] increased concentrations of the hormone, relax in, soften cartilage and ligaments of joints, leading to pain; however, other experimental studies found no relationship between high levels of relax in and increased pelvic mobility and PGP in pregnant women [13]. Asymmetry of the pelvis is also likely to be one of the causes of PGP [4]. Sacroiliac joint (SI joint) motion consisted of rotation and translation of the sacrum relative to the ilium [14]. However, there are few clinical criteria to evaluate changes in pelvic alignment related to LBP and PGP during pregnancy and postpartum recovery. This review sought to identify features of changes in pelvic alignment and posture during pregnancy and postpartum recovery that might be responsible for LBP and PGP.

Methods

This systematic review was carried out following PRISMA guidelines [15]. Articles were researched from November in 2019 to February in 2021. Inclusion criteria were case, cohort and cross-sectional or longitudinal studies, focused on observation of changes in pelvic alignment or posture. Associations between pelvic alignment or posture during pregnancy and postpartum and LBP or PGP were also included. Healthy pregnant women in any stage of pregnancy, without age limits were included. All studies were written in English. Studies related to literature or systematic reviews or clinical trials focusing on use of belts were excluded. Studies including surgeries and traumatic injuries were also excluded. Medline, PubMed, EMBASE, Cinahl, PEDro, and Google scholar were searched. All published articles focusing on the association between posture, pelvic alignment and LBP or PGP in pregnancy and the postpartum period were identified. Search terms were based on keywords of publications. A string search was created adding 'OR' and 'AND' to combine keywords and subject areas. Keywords included: 'pregnant', 'pregnancy', 'postpartum', 'after childbirth', 'puerperium' and 'pelvic alignment', 'sacroiliac joint', 'pubic symphysis', 'posture' and 'pelvic pain', 'pelvic girdle pain', 'low back pain', or 'back pain.' Three authors (AS, AA, TM) searched keywords in selected articles. Extracted data included: study year, study country, study design, study aims, sample sizes, measurements and gestational periods of study populations, measurement instruments, planes of measurements, outcomes, pain, main findings, and conclusions. Three authors then examined the quality of selected articles with the risk of bias assessment tool for non-randomized studies (RoBANS).

Overall risks of bias of each article were examined with RoBANS. This grading system is based on six domains: selection of participants, confounding variables, measurement exposure, blinding of outcome assessments, incomplete outcome data, and selective outcome reporting [16]. Risk of bias was assessed as high, low, or uncertain. RoBANS assesses reliability by examining feasibility and validity [16]. Agreement between reviewers (inter-tester reliability) was determined using Kappa analyses. Statistical Package for the Social Science (IBM SPSS version 20 Inc, Illinois, USA) was used for the analysis.

Result

1,974 studies were identified, but only 18 met all inclusion criteria (Table 1). Five studies reported changes in pelvic alignment during pregnancy and postpartum recovery [17-21]. Five studies focused on pelvic alignment after childbirth [22-26]. Five studies reported changes in posture during pregnancy [27-31], while three observed changes in posture after pregnancy [32-34]. Nine studies reported the relationship between changes in pelvic alignments or posture and LBP or PGP [17,18,20,24-28,30]. One case study, two case-control studies, two cross-sectional studies, and thirteen prospective, longitudinal studies were included. 976 pregnant and postpartum women were covered by studies included in this review and 324 were included as controls. Participants ranged from 18 to 48 years. The period of measurement was divided into three terms: 1. during pregnancy (gestation weeks 10-37), 2. after delivery (from 12 hours to 37 months after delivery), and 3. from 12 weeks gestation to 46 months after delivery. Main outcomes were posture (kyphosis and lordosis) and pelvic alignments (sacroiliac (SI) joints, inter-pubic gap, sacral inclination, pelvic inclination, anterior superior iliac spine (ASIS) and posterior superior iliac spine (PSIS) width). Measurement instruments were computed tomography (CT) (1 study), X-ray (2 studies), ultrasound imaging (3 studies), magnetic resonance imaging (MRI) (1 study), palpation meter (3 studies), clinometer and electro-goniometer (3 studies), three-dimensional (3D) motion capture (3 studies), metro skeletal analysis system (1 study) and a custom-made structured-light illumination scanner (1 study)(Table 1).

Inter-rater reliability, which assesses variation between reviewers, was almost perfect (K=0.86-0.91). Ten of 18 studies had low risk of bias (number of lows: 5-6), eight studies had high or uncertain risk of bias with regard to selection of participants, confounding variables, blinding of outcome assessment, incomplete outcome data, or selective outcome reporting (Table 2). Sample size was small in most studies. In addition, measurements differed between studies, precluding use of a meta-analysis. Three studies included 100 - 200 participants; however, authors and their institutions were the same in two studies [17,19,21]. One of the three studies was a cross-sectional study and compared participants [19]; thus, it did not observe how pelvic alignment changed during and after pregnancy [19].

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Table 1: Characteristics of studies included in this review.

Author & Year	Country	Design	Number of Participants	Age, Mean(Sd)	Period of Measurements	Instrument	Posture	Parts of Measurement
Bullock,1987	Australia	a prospective longitudinal study	34	range 15-35	14gw, 22gw (every 8 weekly interval up to 38 weeks(3 times)	clinometer, electro-goniometer	standing	kyphosis, lordosis, pelvic inclination
Garagiola,1989	USA	a case-control study	14 (control: n=15)	24.1	within 24 hr after delivery	CT	spine	SI joints, SP
Bullock-Saxton, 1991	Australia	a prospective longitudinal study	Study1:n=16, Study2:n=59	study1: 18.4-34.3, study2:18.6-38.2	14-22 gw,30-38gw,6-12 weeks after delivery	clinometer, electro-goniometer	standing	kyphosis, lordosis, pelvic inclination
Scriven, 1995	UK	a prospective longitudinal study	9 (control: n= 42)	not mention	within 24hr after delivery, follow up 37 m	ultrasonography	supine	SP
Franklin,1998	USA	a prospective longitudinal study	12	27.6(4.7)	first and third trimester	metrecom skeletal analysis system	standing	head, shoulder, thoracic & lumbar spine, pelvic tilt ,sacral base angle, knee
Björklund,1999	Sweden	a prospective longitudinal study	49	median 29	12gw, 35gw and 5 m postpartum	ultrasonography	supine	SP width and sift
Wurdinger, 2002	Germany	a prospective longitudinal study	19 (control: n=11)	26.5 (control: 30)	2-5d postpartum, follow up after 12m	MRI	supine	SP, signal intensities of cartilage of the pubic
Gilleard, 2002	Australia	a prospective longitudinal study	9 (control: n=12)	range28-40 (control:21-35)	18gw or less, 24gw, 32gw, 38gw, 8w postpartum	expert vision motion analysis system	standing and sitting	head, thoracic & pelvic segment, hip joint, thoraco-lumbar, cervico-thoracic spine
Kouhkan,2015	Iran	a prospective longitudinal study	30 (control: n=18)	25.4(0.7)	10gw, 21gw and 32gw	flexible ruler, pelvic inclinometer	standing	thoracic & lumbar curvatures, pelvic inclination
Yoo,2015	Korea	a cross-sectional study(?)	19 (control: n=15)	29.54(3.45)	2nd and 3rd trimester	3D spinal diagnostic imaging system	standing	thoracic & lumbar curvatures
Aydin,2015	Turkey	a cross-sectional study	86	28.4(5.7)	within 36 hr after delivery	X-ray, 3D trans perineal ultrasound imaging	standing	SP, SPL
Michonski,2016	Poland	a case study	1	34	every 2 weeks between 17gw and 37gw	a custom-made structured light illumination scanner	standing	kyphosis, lordosis
Yamaguchi,2016	Japan	a cross-sectional study	45 pregnancy, 124 postpartum, 177 nulliparous	24.3(6.3)	6.6(1.8)m pregnancy, or 4.6(1.3) m postpartum, nulliparous	palpation meter	standing	width of pelvis, asymmetry, AWP, PWP

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Ji, 2018	Japan	a prospective longitudinal study	50	32.8(4.5),	12hr and 1month after delivery	X-ray	standing	width of pelvis & PS, PS translation, PSS angle
Morino, 2018	Japan	a prospective longitudinal study	168	31.0(4.7)	12gw, 36gw	palpation meter	standing	width of pelvis, pelvic ante version, asymmetry
Biviá-Roig, 2018	Spain	a case control study	34 (control: n=34)	34.7(3.1)	third trimester, 8(3) w postpartum	electro-magnetic motion capture system	standing	lumbar spine, pelvis
Opala-Berdzik , 2019	Poland	a prospective longitudinal study	13	27.9(2.9)	8-16gw, 35-38gw, 27-31.5w postpartum	digital inclinom-eter	standing	sacral inclina-tion
Morino, 2019	Japan	a prospective longitudinal study	201	30.9(4.5)	12gw, 24gw, 36gw, 1 m postpartum	palpation meter	standing	width of pel-vis, anterior tilt, asymme-try

SP: Symphysis Pubis, SPL: the Superior Pubic Ligament, SI joint: Sacroiliac Joint

Table 2: Assessment of the risk of bias in non-randomized control studies using RoBANS.

Author & Year	Instrument	Selection of Participants	Con-founding Variables	Measurement of Exposure	Blinding of Outcome Assessment	Incomplete Outcome Data	Selective Outcome Reporting	Number of Lows
Aydin, 2015	X-ray, ultrasonog-raphy	low	low	low	low	low	low	6
Ji, 2018	X-ray	low	low	low	low	low	low	6
Opala-Berdzik, 2019	digital inclinom-eter	low	low	low	low	low	low	6
Bullock, 1987	clinometer, elec-tro-goniometer	low	low	low	low	unclear	low	5
Bullock, 1987	clinometer, elec-tro-goniometer	low	low	low	low	unclear	low	5
Björklund, 1999	ultrasonography	low	low	low	low	unclear	low	5
Gilleard, 2002	motion analysis system	low	high	low	low	low	low	5
Morino, 2018	palpation meter	low	low	low	low	unclear	low	5
Biviá-Roig, 2018	motion capture system	low	low	low	high	low	low	5
Morino, 2019	palpation meter	low	low	low	low	low	unclear	5
Garagiola, 1989	CT	low	high	low	high	low	low	4
Bullock-Saxton, 1991	clinometer, elec-tro-goniometer	low	low	low	high	unclear	low	4
Yamaguchi, 2016	palpation meter	high	low	low	low	high	low	4
Scriven, 1995	ultrasonography	low	high	unclear	low	unclear	low	3
Wurdinger, 2002	MRI	unclear	unclear	low	low	unclear	low	3
Yoo, 2015	3D spinal diagnos-tic imaging system	unclear	low	unclear	unclear	low	low	3
Kouhkan, 2015	flexible ruler, pel-vic inclinometer	unclear	high	low	low	low	high	2
Michonski, 2016	a custom-made structured light il-lumination scanner	case study	N/A	N/A	N/A	N/A	N/A	N/A

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Ten studies observed changes of pelvic alignment during pregnancy and postpartum recovery [17-26] (Table 3). Small changes in pelvic anteversion and greater changes in pelvic asymmetry were found during pregnancy [17]. Although sacral inclination did not change during pregnancy, anterior and posterior width and tilt of the pelvis were significantly greater during pregnancy [20,21]. Pelvic tilt decreased after childbirth [21]. The width of the pubic symphysis was 3-18.3 mm immediately after delivery [22,23,26], and decreased during the following month [26].

Table 3: Changes in pelvic alignments.

Author & Year	Instrument	Reliability Of Measurements (Icc)	Period	Parts	Changes (Mean(Sd))	P Value
Garagiola 1989	CT	not described	within 24hr after delivery	1.width of the sacroiliac joints(cm) 2.mean width of the pubic symphysis(cm)	1.0.30 (range,0.2-0.6) 2. 0.65 (range, 0.3-1.1)	N/A
Scriven, 1995	ultrasonography	not described	within 48hr of delivery	1. inter-pubic gap(mm)	1.4.8 (range, 4.3-5.1)(controls)	N/A
Björklund, 1999	ultrasonography	not described	12gw, 35gw, 5m postpartum,	1.symphysis width(mm) 2.symphysis shift (°)	1. 3.4(0.8)→ 4.8(1.6)→ 2.8(1.2) 2. 0.3(0.6) → 0.9(1.1)→ 0.7(0.7)	1.p<.01, 2. p<.05, <.001
Wurdinger, 2002	MRI	not described	postpartum women vs nulliparous women	1. distance of the inter-pubic gap(mm)	1. 6.0 (0.9)(postpartum), 5.0(0.6)(the nulliparous group)	1.p=.0002-.005
Aydin, 2015	X-ray, ultrasonography	SP width: ICC=0.97(0.95-0.98), Narrow SP width:ICC=0.95(0.93-0.97), SPL length: ICC=0.68(0.50-0.80), SP height: ICC=0.85(0.78-0.90)	within 36hr after delivery	1.wide SP wi dth(mm) 2.narrow SP width(mm) 3.SPL length(mm) 4. SPL high(mm)	1.9.01(2.02)(3Dultrasound), 8.55(2.18)(X-ray) 2. 7.09(1.65)(3Dultrasound), 6.70(1.77)(X-ray) 3. 29.63(3.33)(3Dultrasound), 28.13(5.02)(X-ray) 4. 39.63(6.14)(3Dultrasound), 38.35(0.20)(X-ray)	N/A
Yamaguchi, 2016	palpation meter	not described	pregnant, postpartum, nulliparous women	1. anterior pelvic width(mm) 2. posterior pelvic width(mm) 3. pelvic asymmetry(mm)	1. wider in pregnant & postpartum:25.0(2.3)(pre), 24.1(2.3)(post),23.6(1.9)(nul) 2. narrowest in pregnant: 8.2(2.1)(pre), 8.6(2.0)(post), 9.1(1.6)(unl) 3. greater in pregnant & postpartum:4.2(3.0)(pre), 3.7(3.2)(post), 2.8(2.4)(nul)	1. p<.001 2. p=.001- .016 3. p<.001 p= .009-.019
Morino, 2018	palpation meter	anterior posterior pelvis: ICC 2,1=0.992(0.992-1.00) pelvic tilt: ICC 2,1=0.998(0.992-1.00)	12gw, 36gw	1. length of anterior pelvis(mm) 2. length of posterior pelvis(mm) 3.pelvic ante version(mm) 4.pelvic asymmetry(mm)	1. 23.0(2.9)→ 25.4(2.6) 2. 10.8(3.8)→ 11.8(3.5) 3. 2.56(4.72)→ 4.59(5.36) 4. 2.59(2.59)→ 2.25(2.48)	N/A
Ji, 2018	X-ray	not described	within 12hr after delivery, 1m postpartum	1.distance between HICs, FLAMs(mm) 2.PS separation(mm) 3.PS translation(mm) 4.PSS angle(°)	1. HIC: 164.9(21.4)→ 164(21.6), FLAM: 239.1(14.1)→ 237(15.2) 2. 7.9(2.0)→ 6.5(1.4) 3. 4.1(1.6)→ 3.1 (1.2) 4. 13.0(8.1)→ 13.5(7.9)	1.p=.004, p<.001, 2.p=.029

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Morino, 2019	palpation meter	anterior posterior pelvis length: ICC2,1=0.992(0.972-0.999), anterior pelvic tilt: ICC 2,1=0.998(0.992-1.00)	12gw, 24gw, 30gw, 36gw, 1m postpartum	1. anterior width of pelvis(cm) 2. posterior width of pelvis(cm) 3. anterior pelvic tilt(°) 4.pelvic asymmetry(°)	1. increased during pregnancy and decreased in 1m post:23.1(2.8)→ 24.0(3.2)→24.8(2.5)→ 25.4(2.5)→ 23.6(3.1) 2.increase between 12w and30w, between 12w and 36w, no differences between pregnancy and 1m post:10.7(3.6)→ 11.2(3.7)→ 11.4(3.3)→ 11.7(3.6)→not described 3.increased during pregnancy and decreased by 1m post:3.99(5.53)(12gw)→ 5.29(5.33)(36gw) 4.increased in pregnancy, no significant differences between pregnancy and postpartum(not described)	1. p<.001, p=.009-.026, 2.p=.036, p<.001, 3. p=.037, 4.not described
Opala-Berdzik, 2019	digital inclinometer	ICC 3,3=0.91(SD 0.92)	early pregnancy(by 16gw), advanced pregnancy(5-2w before the due date), 6m postpartum	sacral inclination(°)	16.3(5.5)→ 16.8(3.8)→ 16.5(4.6) 1.early→advanced: unchanged: n=8(61.5%), increased: n=3(23.1%), decreased: n=2(15.4%) 2.advanced→6m post: unchanged: n=6(46%), increased: n=3(23.1%), decreased: n=4(30.8%)	P=.75

gw: Gestation Week, SP: Symphysis Pubis, SPL: the Superior Pubic Ligament, SI joint: Sacroiliac Joint, PS: Pubic symphysis, PSS: The Pubic Symphysial Surface, HIC: The Highest Point of Iliac Crest, FLAM: the Furthest Lateral Points of Acetabular Margin

Eight studies observed changes of posture during and after pregnancy [27-34](Table 4). Changes in spinal curvature during pregnancy were inconsistent. Three studies concluded that thoracic curvature and lumbar lordosis significantly increased between the first and third trimesters [28,29,32]. However, two other studies found no significant differences [27,33]. One study reported that pelvic curvature reduced the anterior orientation of the sagittal plane, and that the thoracolumbar spine was less extended, indicating flattened spine curvature [33]. Other studies reported that kyphosis increased by +6-8 degrees from the first to third trimesters [27,29,32]. In addition, the lumbar lordosis angle increased by +7-9 degrees from the first to third trimesters [27-29,31,32]. Yoo et al. [30] found that while thoracic curvature increased significantly from the second to the third trimester, lumbar curvature significantly decreased from the second to the third trimester.

Table 4: Changes in posture.

Author & Year	Instrument	Reliability Of Measurements (Icc)	Period	Parts	Changes (Means(Sd))	P Value
Bullock 1987	clinometer, electro-goniometer	not described	14gw, 22gw (every 8 weekly interval up to 38 weeks(3 times)	1.kyphosis(°) 2.lordosis(°) 3. pelvic inclination(°)	1. increased during pregnancy(+6.6 degree): 44.3(7.2)→47.8(8.1)→50.9(8.4) 2. increased during pregnancy(+7.2 degree):26.7(8.8)→29.4(9.8)→33.9(10.9) 3. 14gw→22gw:decreased , 22gw→3rd : increased:5.8(3.3)→4.5(3.5)→5.1(3.1)	1. p=.000, 2. p=.000 3. p=.057
Franklin 1998	metrecom skeletal analysis system	first trimester: ICC=0.40-0.88, third trimester: ICC=0.47-0.82	1st and 3rd trimester	1.thoracic & lumbar angle(°) 2.pelvic tilt(°) 3.anterior/ posterior displacements at head	1. increase in 3rd: thoracic:31.6(9.4)→34.8(16.0) lumbar: 31.9(-8.7)→37.8(-9.6) 2. increased in 3rd: Rt.:6.4(6.0)→10.0(9.5), Lt.: 7.0(6.8)→11.2(7.6) 3. decreased in 3rd: 81.2(20.7)→53.5(25.8)	1. p<.01 2. p<.01 3. p<.05

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074. DOI: 10.19080/JGWH.2021.21.556074

Kouhkan 2015	flexible ruler, pelvic inclinometer	present study: not described, previous studies: ICC=0.88-0.97	10gw, 21gw and 32gw	1.lumbr angles(°) 2.thoracic angles(°) 3.pelvic inclination(°)	1. increased in pregnancy(T1-T2:+10.3%, T1-T3:+15.7%, T2-T3:4.8%) :46.9(2)→51.7(2.5)→54.3(2.3) 2. increased in pregnancy (T1-T2:+4.9%, T1-T3:+16.7%, T2-T3:+11.2%): 32.4(1.8)→34(1.6)→37.9(1.3) 3. increased in pregnancy(T1-T2:+27.2%, T1-T3:+62.4%, T2-T3:+27.6%): 10.9(0.5)→13.9(0.4)→17.7(0.7)	1. T1vs T2 p=.31, T1vsT3 p=.007, T2vsT3 p=.33 2.T1vsT2 p=.396, T1vsT3 p=.001, T2vsT3 p=.025 3.T1vsT2, T1vsT3, T2vsT3 p<.001
Yoo, 2015	3D spinal diagnostic imaging system (with markers)	not described	2nd and 3rd trimester	1.thoracic curvature(°) 2.lumbar curvature(°) 3.pregnancy vs control	1. significantly increased in the third trimester(+0.97): 10.7 (2.1)→11.5(2.4) vs control:10.6(2.9) 2. significantly increased in the third trimester(+1.02): 8.96(1.7)→9.98(1.9) vs control:7.3(1.3) 3. significant larger in 3rd trimester than control	1. p<.01 2. p<.01 3. p<.05
Michonski 2016	a custom-made structured light illumination scanner	not described	every 2 weeks between 17gw and 37gw	1.kiphosis angles(°) 2.lordosis angles(°)	1.decreased after 27w (changes 7.4) :50.9(2.4) 2.increase in 21 w and decreased after 21w(changes 8.4) :58.1(2.1)	not described
Bullock-Saxton 1991	clinometer, electro-goniometer	not described	14-22 gw,30-38gw,6-12 weeks after delivery	1.kyphosis(°) 2.lordosis(°) 3.pelvic inclination(°)	1.increased in pregnancy and larger in postpartum than in early pregnancy: Stu dy1:26.0(6.086)→34.79(7.714)→35.15(6.98), St udy2:34.45(8.698)→-34.79(7.714) 2.increased in pregnancy and larger in postpartum than early pregnancy: Study1: 43.26 (9.72)→49.54(8.721)→51.33(7.97), Study2: 47.39(9.318)→45.87(8.10) 3.decreased in pregnancy(not significant differences) and smaller in postpartum than in late pregnancy: Study1: 2.29(4.79)→11(4.57)→0.63(4.48), Study2: 2.13(3.49)→2.48(3.33)	1. p<.05 2.p<.005 3.p<.001
Gilleard 2002	expert vision motion analysis system (with markers)	ICC 2,1=0.86-0.727	18gw or less, 24gw, 32gw, 38gw, 8w postpartum	standing 1.pelvic segment 2. thoracic segment 3.cervicothoracic spine 4.thoracolumbar spine: 5.head	1. larger in control:18.0(9.2)→15.0(7.2)→16.0(8.2)→14.5(8.8) 2. no significant changes in during pregnancy: 6. 0(6.9)→5.5(4.6)→3.5(4.8)→4.5(4.0) 3. no significant changes in during pregnancy: 5. 0(10.7)→3.0(6.5)→2.0(7.3)→1.0(7.3) 4. larger in control: :24.0(13.7)→20.0(11.2)→19. 5(11.9)→18.5(11.9) 5. no significant changes in during pregnancy: 1.0(6.5)→2.5(4.7)→1.5(5.3)→5.0(6.1)	p=.01, .003
Biviá-Roig 2018	electromagnetic motion capture system (with markers)	not described	3rd trimester, 8(3) w after delivery	1.lumber spine(°) 2.pelvis(°)	1.31.7(10.5)→33.9(9.3) 2.21.3(8.7)→22.7(7.6)	not described

gw: Gestation Week

The relationship between alignment changes and pain was discussed in eight studies [17,18,20,24-28,30](Table 5). All pelvic pain appeared during pregnancy and some persisted after delivery. One study targeted women with severe PGP after delivery [25]. Six studies reported a relationship between changes in pelvic alignments and PGP [17,18,20,24-26]. Four studies found that pelvic changes, including sacral inclination, the inter-pubic gap and the distance between the anterior and posterior pelvis was not significantly related to pain [18,20,25,26]. One study concluded that the increase in pelvic asymmetry presented the greatest risk of sacroiliac joint pain [17]. Another study found that women with PGP that lasted more than a month demonstrated a larger reduction in pubic symphysis (PS) translation than recovered participants [26]. Two studies that focused on the relationship between posture changes and LBP during pregnancy found no significant relationship between LBP and posture in the thoracic, lumbar, and pelvic areas [27,28].

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Table 5: Comparisons of women with and without LBP/PGP.

Author & Year	Pain at recruitment	Prevalence of pain	Comparisons	Results	P value
Morino, 2018	no pain	44.4% at 36w	SIJP vs non-SIJP	1.changes in pelvic anteversion(12-36w):smaller in SIJP 2.changes in pelvic asymmetry(12-36w):greater in SIJP 3.pelvic asymmetry associated with SIJP	1.p=.032 2.p=.007 3. odds ratio=1.133(95%CI, 1.028-1.249)
Björklund, 1999	no pain	49% during pregnancy, 19% at 5m postpartum	non-pain vs pain during pregnancy	greater increase in SP width & larger SP shift in pain group	p<.05, <.001
Opala-Berdzik, 2019	no pain	61.5% LBP at advanced pregnancy & 38.5% at postpartum	1. early pregnant vs advanced pregnancy 2. 6m postpartum vs advanced pregnant	no significant correlation between LBP and sacral inclination at advanced pregnancy and postpartum	N/A
Scriven, 1995	pubic pain	50% persistent PGP in follow up	symptomatic females(n=9) and included the diagnosis of diastasis(n=2) vs control(non-symptomatic postpartum)	inter-pubic gap: larger for the symptomatic females(20.0(range 10.0-35.0)) than for controls (4.8(range 4.3-5.1)) within 48hr of delivery	p<.001
Wurdinger, 2002	6 of 19 postpartum women with severe PGP	N/A	asymptomatic vs symptomatic postpartum women vs nulliparous women	1.distance of the inter-pubic gaps: larger in asymptomatic (6.0 (0.9)) & symptomatic(6.0 (1.4)) postpartum than nulliparous(5.0(0.6)). 2.no significant differences between symptomatic and asymptomatic	1.p=.0002-.005
Ji, 2018	with PSP	27% PSP non-recovery	PSP recovery vs PSP non-recovery	width of PS translation: smaller in recovery than in non-recovery: PSP recovery:1.1(0.8), non-recovery:1.8(1.2)	p=.029
Bullock, 1987	no pain before pregnancy	88.2% during pregnancy	1st vs 2nd vs 3rd trimester in pregnancy(by 36w)	LBP: 62% experienced at the1st and 2nd trimester, 76% experienced at the 3rd trimester Association between changes in posture and LBP/PGP :no significant relationship between LBP and posture	N/A
Franklin, 1998	mixed	83% during pregnancy	1st vs 3rd trimester	1.LBP(VAS)(cm) :0.4(1.0)→1.6(1.6) no significant relationship between changes in posture and LBP	p<.05
Yoo, 2015	not described	N/A	2nd vs 3rd trimester	1.LBP VAS: significantly increased in 3rd trimester 4.2(3.5)→4.8(3.7) 2.Pelvis VAS: significantly increased in 3rd trimester 5.8(3.1)→7.3(1.8) Association between changes in posture and LBP/PGP: not described	1. p<.05 2. p<.05

LBP: Low Back Pain, PGP: Pelvic Girdle Pain, SIJP: Sacroiliac Joint Pain, SP: Symphysis Pubis, PS: Pubic Symphysis, PSP: Pubic Symphysis Pain, VAS: Visual Analog Scale

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

Discussion

The purposes of this review were to clarify features of changes in pelvic alignment in pregnancy and recovery, and to find the relationship between changes in pelvic alignments or posture, and LBP or PGP. Eighteen studies observed changes in pelvic alignments and posture during pregnancy and postpartum recovery. Most studies had low risk of bias; however, most also had small sample sizes and used different measurements. Thus, we could not employ meta-analysis. These studies investigated how changes in posture and pelvic alignment related to LBP or PGP. To the best of our knowledge, this is the first systematic review of changes in pelvic alignment and posture to demonstrate relationships with LBP and PGP resulting from pregnancy. Anterior and posterior width and tilt of the pelvis and width of the pubic symphysis (PS) were significantly greater during pregnancy and decreased thereafter [18,22,24-26]. However, sacral inclination did not change significantly during pregnancy [20,27,32]. One study also concluded that upper body spinal curvature was not significantly changed during pregnancy [33]. Other studies reported that kyphosis increased by +6-8 degrees from the first to third trimesters [27,29,32]. In addition, the lumbar lordosis angle increased by +7-9 degrees from the first to third trimesters [27-29,31,32]. Most studies found that changes in anterior and posterior pelvic width were not significantly related to LBP or PGP [17,18,20,35]. One study assumed that great pelvic asymmetry was associated with risk of PGP [17]. A large reduction PS translation was also related to PGP [26].

Pelvic width increased during pregnancy regardless of measurement extolments. Those extolments were used differently depending on the measurement area. Pelvic anterior and posterior alignments were measured with a palpation meter in most studies [17,19,21] and PS and SI joint distances were measured with ultrasonography or radiography [18,22-26]. Static assessments involving palpation were not consistently reliable. Studies focusing on inter-examiner and intra-examiner agreement for assessing pelvic alignment, including ASIS, PSIS, and sacroiliac anatomical landmarks using palpation had low reliability (ICC; 0.27~0.80, kappa; 0.18) and the degree to which they matched was <50% (36-38). Some previous studies reported that correlation coefficients and validity coefficients indicated moderate or poor correlations [39,40]. However, assessments using palpation to investigate the reliability of iliac crest height differences and standing antero-posterior (AP) measurements of the pelvis were high (ICC>0.9) [41]. Although clinicians were encouraged to consider the palpation meter as a reliable alternative to radiographic measurement of pelvic crest inequalities, palpation meters are less accurate, providing an indirect estimate of true leg length discrepancy in symptomatic patients (ICC 0.70) [41]. Clinician experience, palpation skills, including pelvic anatomical knowledge, and symptomatic or asymptomatic populations affect the results. Some studies in this review used palpation meters to assess ASIS, PSIS, and AP of the pelvis [17,19,21]. While studies should consider physician palpation skills, one study did not mention skills [19]. CT and MRI are useful to measure distance of PS and SI joints as well as ligament injuries [42,43]. One study examined the accuracy of 3D sonographic measurements of PS distension in comparison with plain X-ray pelvic radiographs and assessed inter performer reliability [23]. They found that PS width, superior pubic ligament length, and PS height can be reliably measured with 3D ultrasonography (ICC 0.66-0.7) [23]. Sonographic and radiographic assessments should be used to observe minute changes in pelvic alignment. Clinometers, electro-goniometers, flexible rulers, and motion capture were used to measure changes in posture during pregnancy and recovery [27-30,32-34]. Most studies found kyphosis and lumbar lordosis increased during pregnancy [27-30,32]. However, one study using motion capture concluded that there were no significant differences in the position of the lumbar spine or pelvis among pregnant women [34]. Another study using motion capture found upper-body posture did not change significantly in pregnancy [33]. Results of 3D analysis differed from those of manual measurements. Two studies focused on the association between posture and LBP and PGP using clinometers, electro-goniometers, and metrecom skeletal analysis systems [27,28]. They concluded that there was no significant relationship between LBP and posture [27,28].

Generally, changes in posture and pelvic tilt during pregnancy are regarded as natural risks for LBP and PGP. The prevalence of LBP and PGP from the 24th week onward were 71.3% and 64.7% respectively [5]. However, changes in posture during pregnancy had no significant influence on LBP or PGP. Bullock et al. [27] observed changes in posture, including kyphosis and lordosis angles, as well as pelvic inclination from early to late pregnancy. They found that prevalence of LBP or PGP was 88.2% and there was no significant association between changes in posture and pain [27]. According to Franklin et al. [28], changes in lumbar angle and pelvic tilt were not significantly related to LBP, while those angles increased significantly from the first to the third trimester. Most studies found that kyphosis and lordosis increased during pregnancy and that these changes persisted into postpartum recovery [32-34]. However, those changes are not strongly related to causes of LBP or PGP [27,28,30]. Pelvic tilt, ASIS width, PSIS width, PS width, sacral inclination, and pelvic asymmetry were recorded from early pregnancy to recovery [18-26]. Most studies found that those widths and angles increased during pregnancy and decreased thereafter. Only 15% of pregnant women increased sacral inclination angles and in 61% of patients, those angles did not change in pregnancy [20]. Anterior width one month after childbirth was greater than at 12 weeks gestation [21] and in women who have not borne children [19]. As a result, postpartum pelvic alignment may not recover completely. Natural changes of pelvic width are not strongly related to LBP and PGP. However, pelvic asymmetry and PS translation were significantly related to persistent PGP in pregnancy and recovery [17,24,26]. The sacrum can move with respect to the ilium with six degrees of freedom and the SI joint range of motion in flexion/extension is about 3 degrees, whereas axial rotation is about 1.5 degrees [44].

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

In women, the sacrum has higher mobility than in men [44,45]. The higher mobility of the SI joint during pregnancy may result in pelvic asymmetry. Pelvic asymmetry occurs frequently as a physiologic alteration that adapts the locomotor system and is observed in healthy subjects with no evidence of any dysfunction [46-49]. Saulicz et al. [50] reported that pelvic asymmetry was present in 67.3 % of healthy women with no LBP or PGP. Adhia et al. [51] concluded that women with SI joint pain exhibited significantly different innominate movement patterns and trends of rotation compared to those without pain. Thus, a close look at asymmetrical changes may reveal alterations that cause pain, although the pathology remains uncertain.

The strengths of this review include thoroughness of the literature search, which examined multiple databases, adhering to PRISMA and assessing studies examined for risk of bias. This is the first systematic review of natural changes in pelvic alignment and posture from pregnancy to postpartum recovery and their association with LBP and PGP. However, various measurements were used to quantify changes and some studies used low-reliability or low-validity instruments or did not include measurements at all. In addition, most studies had small sample sizes. No study reported a priori sample size calculations. Thus, it is difficult to compare changes and to verify the accuracy of changes reported in the obstetrical literature. The other limitation is that only English articles were examined in this review. Thus, language limitations may affect the results.

Conclusion

This systematic review is inconclusive regarding the nature of changes in pelvic alignment and posture and their association with LBP or PGP during pregnancy and postpartum recovery. Included studies had small sample sizes and used different measurements, some of which depended upon low-reliability or low-validity instruments. We could not unequivocally identify features of changes in pelvic alignments and posture, although we confirmed patterns of those changes. Changes in pelvic alignment and posture during pregnancy may persist into postpartum recovery. Although changes in posture are unrelated to LBP or PGP, asymmetric changes in pelvic alignment may cause pain. Thus, asymmetric changes should be carefully monitored to prevent persistent PGP. Further studies of higher methodological quality are required to confirm and extend the findings.

Acknowledgement

This work was supported by JSPS KAKENHI Grant Number 20K19160.

References

1. Sakamoto A, Nakagawa H, Nakagawa H, Hoshi K, Gamada K, et al. (2019) Natural history for persistent low back and pelvic girdle pain in Japanese women 12 months after childbirth: a longitudinal pilot study. Pan Asian J Obs Gyn 2(2): 57-64.
2. Stuge B (2010) Diagnosis and treatment of pelvic girdle pain. Tidsskr Nor Laegeforen 130(21): 2141-2145.
3. Wu WH, Meijer OG, Uegaki K, Mens JM, Dieen VJH, et al. (2004) Pregnancy-related pelvic girdle pain (PPP), I: Terminology, clinical presentation, and prevalence. Eur Spine J 13(7): 575-589.
4. Sakamoto A, Gamada K (2019) Altered musculoskeletal mechanics as risk factors for postpartum pelvic girdle pain: a literature review. J Phys Ther Sci 31(10): 831-838.
5. Kovacs FM, Garcia E, Royuela A, Gonzalez L, Abraira V, et al. (2012) Prevalence and factors associated with low back pain and pelvic girdle pain during pregnancy: a multicenter study conducted in the Spanish National Health Service. Spine 37(17): 1516-1533.
6. Sipko T, Grygier D, Barczyk K, Eliasz G (2010) The occurrence of strain symptoms in the lumbosacral region and pelvis during pregnancy and after childbirth. J Manipulative Physiol Ther 33(5): 370-377.
7. Mens JMA, Pool-Goudzwaard A (2017) The transverse abdominal muscle is excessively active during active straight leg raising in pregnancy-related posterior pelvic girdle pain: an observational study. BMC Musculoskelet Disord 18(1): 1-7.
8. Kennedy N, Quinton A, Brown C, Peek MJ, Benzie R, et al. (2017) Changes in maternal abdominal subcutaneous fat layers using ultrasound: A longitudinal study. Obes Res Clin Pract 11(6): 655-664.
9. House M, McCabe R, Socrate S (2013) Using imaging-based, three-dimensional models of the cervix and uterus for studies of cervical changes during pregnancy. Clin Anat 26(1): 97-104.
10. Nott JP, Bonney EA, Pickering JD, Simpson NAB (2016) The structure and function of the cervix during pregnancy. Translational Research in Anatomy 2: 1-7.
11. Aldabe D, Milosavljevic S, Bussey MD (2012) Is pregnancy related pelvic girdle pain associated with altered kinematic, kinetic and motor control of the pelvis? A systematic review. Eur Spine J 21(9): 1777-1787.
12. Vollestad NK, Torjesen PA, Robinson HS (2012) Association between the serum levels of relax in and responses to the active straight leg raise test in pregnancy. Man Ther 17(3): 225-230.
13. Aldabe D, Ribeiro DC, Milosavljevic S, Dawn Bussey M (2012) Pregnancy-related pelvic girdle pain and its relationship with relax in levels during pregnancy: a systematic review. Eur Spine J 21(9): 1769-1776.
14. Hammer N, Scholze M, Kibsgard T, Klima S, Schleifenbaum S, et al. (2019) Physiological *In vitro* sacroiliac joint motion: a study on three-dimensional posterior pelvic ring kinematics. J Anat 234(3): 346-358.
15. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gotzsche PC, et al. (2009) The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. Journal of Clinical Epidemiology 62(10): e1-34.
16. Kim B, Park JE, Lee YJ, Hyun-Ju S, Seung-Soo S, et al. (2013) Testing a tool for assessing the risk of bias for non randomised studies showed moderate reliability and promising validity. J Clin Epidemiol 66(4): 408-414.
17. Morino S, Ishihara M, Umezaki F, Hatanaka H, Ymashita M, et al. (2018) Pelvic alignment risk factors associated with sacroiliac joint pain during pregnancy. Clinical and experimental obstetrics & gynecology 45(6): 850-854.
18. Björklund K, Nordströ M, Bergströ S (1999) Sonographic assessment of symphyseal joint distention during pregnancy and post partum with special reference to pelvic pain. Acta Obstet Gynecol Scand 78(2): 125-130.

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

19. Yamaguchi M, Matsumoto D, Morino S, Nishiguchi S, Fukutani N, et al. (2016) Comparison of pelvic alignment among never-pregnant women, pregnant women, and postpartum women (pelvic alignment and pregnancy). J Women's Health Care 5(1): 1-5.

20. Opala-berdzik A, Cieślińska-Świder J, Gnat R (2019) A prospective longitudinal comparison of the sacral inclination angle in women between their early and advanced pregnancy and 6-month postpartum follow-up. Acta Bioeng Biomech 21(3): 127-134.

21. Morino S, Ishihara M, Umezaki F, Hatanaka H, Yamashita M, et al. (2019) Pelvic alignment changes during the perinatal period. PLoS One 14(10): e0223776.

22. Garagiola MD, Tarver DR, Gibson M, Rogers ER, Wass LJ, et al. (1989) Anatomic changes after uncomplicated in the pelvis vaginal delivery: a CT study on 14 women. AJR 153(6): 1239-1241.

23. Aydin S, Bakar RZ, Aydin CA, Ozcan P (2016) Assessment of postpartum symphysis pubis distention with 3D ultrasonography: a novel method. Clinical imaging 40(2): 185-190.

24. Scriven WM, Jones AD, McKnight L (1995) The importance of pubic pain following childbirth: a clinical and ultrasonographic study of diastasis of the pubic symphysis. J R Soc Med 88(1): 28-30.

25. Wurdinger S, Humbsch K, Reichenbach JR, Peiker G, Seewald HJ, et al. (2002) MRI of the pelvic ring joints postpartum: normal and pathological findings. J Magn Reson Imaging 15(3): 324-329.

26. Ji X, Takahashi M, Morino S, Takakuwa T, Iijima H, et al. (2018) Postpartum radiographic changes in pelvic morphology and its relation with symptoms of pregnancy-related symphysis pain. clinical and experimental obstetrics & gynecology 5: 665-670.

27. Bullock JE, Jull GA, Bullock MI (1987) The relationship of low back pain to postural changes during pregnancy. Aust J Physiother 33(1): 10-17.

28. Franklin EM, Conner- Kerr T (1998) An analysis of posture and back pain in the first and third trimesters of pregnancy. J Orthop Sports Phys Ther 28(3): 133-138.

29. Kouhkan S, Rahimi A, Ghasemi M, Naimi S, Baghban A (2015) Postural Changes during First Pregnancy. British Journal of Medicine and Medical Research 7(9): 744-753.

30. Yoo H, Shin D, Song C (2015) Changes in the spinal curvature, degree of pain, balance ability, and gait ability according to pregnancy period in pregnant and nonpregnant women. J Phys Ther Sci 27(1): 279-284.

31. Michonski J, Walesiak K, Pakula A, Glinkowski W, Sitnik R, et al. (2016) Monitoring of spine curvatures and posture during pregnancy using surface topography - case study and suggestion of method. Scoliosis Spinal Disord 11(31): 73-91.

32. Bullock-Saxton EJ (1991) Changes in posture associated with pregnancy and the early post-natal period measured in standing. Phpwlhrrapj Theory and Pmclice 7(2): 103-109.

33. Gilleard WL, Crosbie J, Smith R (2002) Static trunk posture in sitting and standing during pregnancy and early postpartum. Arch Phys Med Rehabil 83(12): 1739-1744.

34. Bivia-Roig G, Lison JF, Sanchez-Zuriaga D (2018) Changes in trunk posture and muscle responses in standing during pregnancy and postpartum. PLoS One 13(3): e0194853.

35. Gutke A, Boissonnault J, Brook G, Stuge B (2018) The Severity and Impact of Pelvic Girdle Pain and Low-Back Pain in Pregnancy: A Multinational Study. J Womens Health (Larchmt) 27(4): 510-517.

36. O'Haire C, Gibbons P (2000) Inter-examiner and intra-examiner agreement for assessing sacroiliac anatomical landmarks using palpation and observation: pilot study. Man Ther 5(1): 13-20.

37. Freburger JK, Riddle DL (1999) Measurement of sacroiliac joint dysfunction: a multicenter Intertester reliability study. Phys Ther 79(12): 1134-1141.

38. Piva SR, Erhard RE, Childs JD, Hicks G, Al-Abdulmohsin H, et al. (2003) Reliability of measuring iliac crest level in the standing and sitting position using a new measurement device. Journal of Manipulative and Physiological Therapeutics 26(7): 437-441.

39. Costa DBR, Armijo-Olivo S, Gadotti I, Warren S, Reid DC, et al. (2010) Reliability of scapular positioning measurement procedure using the palpation meter (PALM). Physiotherapy 96(1): 59-67.

40. Hangins M, Brown M, Cook C, Gstalder K, Kam M, et al. (1998) Intratester and intertester reliability of the palpation meter(PALM) in measuring pelvic position. The journal of manual & manipulative therapy 6(3): 130-136.

41. Petrone RM, Guinn J, Reddin A, Sutlive GJ, Flynn WT, et al. (2003) The accuracy of the palpation meter (palm) for measuring pelvic crest height difference and leg length discrepancy. J Orthop Sports Phys Ther 33(6): 319-327.

42. Huerta-Enochian SG, Katz LV, Fox KL, Hamlin AJ, Kollath PJ, et al. (2006) Magnetic resonance-based serial pelvimetry: Do maternal pelvic dimensions change during pregnancy? Am J Obstet Gynecol 194(6): 1689-1694.

43. Lenhard M, Johnson T, Weckbach S, Nikolaou K, Friese K, et al. (2009) Three-dimensional pelvimetry by computed tomography. Radiol Med 114(5): 827-834.

44. Kiapour A, Joukar A, Elgafy H, Erbulut DU, Agarwal AK, et al. (2020) Biomechanics of the sacroiliac joint: anatomy, function, biomechanics, sexual dimorphism, and causes of pain. Int J Spine Surg 14(Suppl 1): 3-13.

45. Vleeming A, Schuenke DM, Masi TA, Carreiro EJ, Danneels L, et al. (2012) The sacroiliac joint: an overview of its anatomy, function and potential clinical implications. Journal of anatomy 221(6): 537-567.

46. Gnat R, Saulicz E, Biaty M, Ktaptocz P (2009) Does pelvic asymmetry always mean pathology? Analysis of mechanical factors leading to the asymmetry. Journal of human kinetic 21: 23-35.

47. Al-Eisa E, Egan D, Wassersug R (2004) Fluctuating asymmetry and low back pain. Evol Hum Behav 25(1): 31-37.

48. Al-Eisa E, Egan D, Deluzio K, Wassersug R (2006) Effects of pelvic skeletal asymmetry on trunk movement three-dimensional analysis in healthy individuals versus patients with mechanical low back pain. Spine 31(3): E71-E79.

49. Al-Eisa E, Egan D, Deluzio KRW (2006) Effects of pelvic asymmetry and low back pain on trunk kinematics during sitting: a comparison with standing. Spine 31(5): E135-E143.

50. Saulicz E, Bacik B, Saulicz M, Gnat R (2001) Asymmetrie des bekens und funktionsstorung von iliosakralgelenken. Eine studie an gesunden ohne beschwerden an der lendenwirbelsaule. Manuelle Medizin 39: 312-319.

51. Adhia DB, Milosavljevic S, Tumilty S, Bussey MD (2016) Innominate movement patterns, rotation trends and range of motion in individuals with low back pain of sacroiliac joint origin. Manual therapy 21: 100-108.

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

DOI: 10.19080/JGWH.2021.21.556074

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074

How to cite this article: Asuka S, Akino A, Tsuyoshi M, Kazuyoshi G. Association of Pelvic Alignment and Posture in Pregnancy with Lower Back or Pelvic Girdle Pain During Postpartum Recovery: Myth or Reality? A Systematic Review. J Gynecol Women's Health. 2021: 21(5): 556074.
DOI: 10.19080/JGWH.2021.21.556074