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an initial exploration

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Correlations between the active straight leg raise, sleep and somatosensory sensitivity during pregnancy with post-partum lumbopelvic pain: an initial exploration

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Abstract

Background and aims: For some women, lumbopelvic pain (LPP) developed during pregnancy becomes a continuing post-partum problem. Increased understanding of potential prognostic factors is required. This study investigated whether active straight leg raise (ASLR), sleep dysfunction and pressure pain sensitivity during pregnancy are correlated with LPP intensity and quality, disability, and physical health-related quality of life (HRQoL) post-partum.
Methods: An exploratory, prospective cohort study design was used. Baseline factors of interest were: (1) ASLR, (2) Pittsburgh Sleep Quality Index, and (3) pressure pain thresholds (PPTs) collected from pregnant women from sites local and distal to the lumbopelvic area. Follow-up data collected 11–18 months post-partum ($n=29$) were: (1) pain intensity score (numerical rating scale), (2) pain quality (McGill Pain Questionnaire), (3) disability (Pelvic Girdle Questionnaire), and (4) HRQoL (36-item Short Form Health Survey). Correlation analysis was performed.
Results: Greater difficulty with an ASLR during pregnancy correlated with lower post-partum physical HRQoL scores ($r=-0.563$, $p=0.002$). Likewise, reduced PPTs at the sacrum during pregnancy was correlated with a higher post-partum pain quality score ($r=-0.384$, $p=0.040$).
Conclusions: In this cohort, findings indicate that poor ASLR performance and localised pressure pain hypersensitivity at the pelvis during pregnancy are correlated with post-partum physical HRQoL and pain quality, respectively.
Implications: Pain sensitivity may contribute to the prognosis of women with LPP during pregnancy. These explorative findings may be important for designing larger prognostic studies and may assist in directing potential pain management in post-partum LPP.

Keywords: pelvic girdle pain; pregnancy; post-partum; sensitivity; lumbopelvic.

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1 Introduction

Low back and pelvic pain are common in pregnancy [1], with both lumbar and pelvic girdle structures potential sources of musculoskeletal during this life stage. As a full physical examination is required to differentiate between lumbar and pelvic girdle pain, and the functional consequences of musculoskeletal pain in these two areas are likely to be very similar, the label of pregnancy-related lumbopelvic pain (LPP) has been adopted as an umbrella term. Pregnancy-related LPP generally resolves within 3–6 months post-partum [2], but for up to 10% of women symptoms can persist for up to 3 years [3] with significant associated disability and reduced health related quality of life (HRQoL) [4]. Contemporary understanding of LPP emphasises a multidimensional interaction of neurophysiological, psychological, physical and lifestyle factors, which can all potentially influence pain sensitivity, pain perception and disability behaviours [5–7].

The active straight leg raise (ASLR) is a clinical assessment of load transference through the pelvis. Poor performance of an ASLR during pregnancy has been associated with ongoing pain and disability post-partum [8, 9]. A recent finding that the ASLR becomes positive in the presence of experimental pain and hyperalgesia via injection

of hypertonic saline in the long posterior sacroiliac ligament [10] suggests a mechanistic link between the ASLR, pain and hyperalgesia.

Reduced quality of sleep has also been associated with post-partum LPP in a cross-sectional study [11]. During both pregnancy and in the post-partum period, reduced sleep quality is common and has been associated with negative effects on maternal physical and mental health [12, 13]. Interestingly, fewer hours of sleep per day can be a prognostic factor for LPP during pregnancy [1]. However, the contribution of altered sleep quality during pregnancy to post-partum LPP has not been widely examined.

Decreased pressure pain thresholds (PPTs) have been found during pregnancy [10, 14] although it is currently unknown whether the reduced PPTs are a prognostic factor for ongoing post-partum LPP [15]. Investigating the relationship between PPTs during pregnancy and post-partum LPP may therefore provide further insight into the potential contribution of sensitised pain mechanisms to this disorder.

This explorative study investigated the relationships between the ASLR, altered sleep quality, pain sensitivity during pregnancy, with post-partum measures of pain intensity, pain quality, disability and physical HRQoL. It was hypothesised that (1) greater difficulty with an ASLR, (2) poorer sleep quality, and (3) increased pressure pain sensitivity during pregnancy would be correlated with greater post-partum LPP intensity, altered pain quality, higher disability, and reduced HRQoL. These three independent variables were of interest because of known links between pain sensitivity and the ASLR [16], and pain sensitivity and sleep disturbance [17].

2 Materials and methods

2.1 Participants

In this prospective cohort study, a cohort of pregnant women were recruited from September to December 2012 in Perth, Western Australia as previously described in a cross-sectional study of pain sensitivity during pregnancy [10]. These women were included on the basis that they were pregnant and healthy throughout the 2nd and 3rd trimesters of their pregnancies. They were excluded if they had neurological, rheumatological, or systemic diseases at baseline, which could influence the outcome of the study. For follow-up, the original cohort participants were contacted via email and telephone between 11 and 18 months post-partum and asked to complete the follow-up questionnaire. The completed surveys were returned via email, fax, or post. The study was approved by Curtin University's Human Research Ethics Committee (HR 210/2012) and followed the Helsinki declaration. All participants provided written informed consent at the time of entering the study covering collection of data at inclusion and follow-up.

2.2 Participant characteristics at inclusion

Participant characteristics were collected at baseline for age, height, weight, stage of pregnancy, past history of LPP, present occurrence of LPP and parity. To further characterise the study cohort, participants' psychological profiles were determined using the Depression Anxiety and Stress Scale, Pain Catastrophizing Scale and Tampa Scale for Kinesiophobia. Participants also provided data for current pain and LPP disability at baseline [10].

2.3 The active straight leg raise during pregnancy

Lying supine, participants rated, on a scale of 0–5 (0 = not difficult at all, 5 = unable to do), the perceived difficulty in lifting their straight leg approximately 20 cm off the bed. To ensure the stability of the results from the test, the procedure was repeated three times on each side and the average was extracted for data analysis. Moreover, the values from both sides (left and right) were added and used as the ASLR score which is in accordance with previous procedures [18]. The average scores for each leg were combined to provide a maximum total score out of 10, with a higher score indicating more difficulty with the task.

2.4 Sleep quality during pregnancy

The Pittsburgh Sleep Quality Index (PSQI) is a self-reported method of assessing sleep. A total score is provided (out of 21) with a higher score indicating poorer sleep quality.

2.5 Pressure pain sensitivity during pregnancy

Sensitivity to pressure was assessed using pressure algometry. A hand-held pressure algometer (Algometer®, Somedic Sales, Hörby, Sweden) was used to assess the mechanical sensitivity of deep tissues. The pressure

algometer has a handle and a 1 cm^2 probe, which was covered with a disposable latex sheath at the tip. The applied pressure is gauged and can be read on a digital display. Pressure was gradually increased at a rate of 30 kPa/s until the participant pressed a button to capture the pressure intensity and notify the assessor of "the point at which the pressure sensation becomes just painful", defined as the PPT. The PPT assessment was conducted bilaterally at 30 s intervals at the following sites [10]: 1 cm lateral to the spinous process of S2; long posterior sacroiliac ligament; over the muscle bulk of the paraspinal muscles lateral to L5, 3–5 cm lateral to the spinous process; the gastrocnemius muscle, mid-way between calcaneus and the popliteal line; and over the bulk of the medial part of the deltoid muscle. Three measures were taken and averaged for each site and across bilateral sites since these were not significantly different [10].

2.6 Post-partum pain intensity

A numerical rating scale (NRS) was used as a unidimensional, single item self-report measure of LPP intensity. Participants were asked to rate their current LPP level from 0 to 10 (0 = no pain, 10 = worst imaginable pain), the same question presented as baseline demographics at inclusion.

2.7 Post-partum pain quality

The total Pain Rating Index component of the McGill Pain Questionnaire is widely utilised self-report questionnaire used to quantify and characterise pain. It comprises 20 categories from which participants select the words that best describe their pain, thus providing information that may be more akin to the individual experience of pain compared to simple ratings of intensity. The total Pain Rating Index was scored based on the rank value of the descriptors in each category from 0 (least pain) to 78 (most pain).

2.8 Post-partum disability

The Pelvic Girdle Questionnaire (PGQ) is a self-report, condition-specific measure for people with pelvic girdle pain but has also been utilised with more broadly captured pregnancy related LPP [10]. A total score was provided out of 75. Higher scores are associated with higher levels of disability. This measure was also used for baseline demographics at inclusion.

2.9 Post-partum physical HRQoL

The 36-item Short Form Health Survey provides a measure of multiple health aspects. The "physical component score" was used in this study, with a lower score indicating reduced physical HRQoL. It was scored using Quality Metrics Health Outcomes Scoring Software 4.0. United States Norms from 1998 were used to conduct T-score based scoring, where raw results are transformed such that a resultant score of 50 is the mean, and a 10 point increment represent 1 standard deviation (SD).

2.10 Analysis

A priori it was decided to investigate the ASLR, sleep quality and somatosensory sensitivity as potential factors correlated with post-partum outcomes. The final sample size at baseline [10] allowed for this limited assessment.

Descriptive statistics were performed at baseline and follow-up to describe the cohort characteristics. Baseline comparisons between those in the final sample, versus those lost at follow-up, were made with Mann-Whitney *U*-tests or Pearson's χ^2 tests as indicated by the data type. To assist with the interpretation, key baseline and follow-up variables were reported for those without (NRS = 0) and with (NRS > 0) pain at follow-up. Follow-up variables were not normally distributed so logarithmic, inverse and square root transformations were conducted. As this did not normalise the data, non-parametric correlations (Spearman's ρ correlations) were performed on the original data. STATA 15.0 (for Mac) was used to conduct all data analysis. Due to the small sample we were unable to correct for multiple comparisons, and as such an alpha level of 0.05 was selected.

3 Results

Thirty-nine women were recruited at baseline [10]. Participant characteristics at baseline are provided in Table 1. Six participants were lost to follow-up, three participants were excluded at follow-up as they were currently pregnant, and a fourth was excluded due to recent spinal surgery. Thus, 29 women constituted the final study sample used for analysis. Baseline measures of the final study sample did not differ from those of participants who were excluded or lost to follow-up (Table 1, all comparisons $p > 0.05$). The participants were on average 15 (SD = 2.0) months post-partum at follow-up. At baseline,

Table 1: Baseline demographic characteristics of the study sample.

	Baseline sample $n=39$	Women followed up post-partum $n=29$	Women excluded/lost from follow-up $n=10$
Age (years)	32 (5)	32 (4)	31.5 (3)
Height (cm)	168 (9)	167 (10)	172 (8)
Weight (kg)	77 (16)	77 (12)	79 (22)
Stage of pregnancy (weeks)	32 (12)	32 (12)	30 (12)
Previous history of LPP (% Yes)	51%	52%	50%
Current LPP pain (% Yes)	85%	86%	80%
Parity (%)			
0	74%	76%	70%
1	21%	21%	20%
2	5%	3%	10%
DASS – 21			
Depression	2 (4)	2 (4)	2 (4)
Anxiety	4 (4)	2 (4)	5 (4)
Stress	8 (8)	8 (8)	7 (12)
Pain Catastrophising Scale- Total	5 (7)	4 (9)	7.5 (8)
Tampa Scale for Kinesiophobia- Total	32.5 (12)	33 (12)	32 (16)
Pelvic Girdle Questionnaire	26 (35)	28 (26)	17 (36)
Current pain	2 (4)	2 (3)	1.5 (5)

LPP = lumbopelvic pain; DASS = depression anxiety and stress scale. Reported as median (interquartile range) unless otherwise indicated.

the women who remained in the study at follow-up had reported low to moderate levels of pain and disability, with a median (interquartile range) NRS for current pain of 2 (SD = 3) and PGQ score of 28 (SD = 26).

Of the 29 participants remaining at follow-up, 12 (41%) reported continued pain at that point in time. Descriptive measures of the baseline variables (ASLR, PSQI, PPT's) and the follow-up outcome variables (pain intensity, pain quality, disability, physical HRQoL) are reported in Table 2.

Greater difficulty on the ASLR during pregnancy showed a moderate to good correlation with the poorer physical HRQoL on the 36-Item Short Form Health Survey ($r = -0.563$, $p = 0.002$). A fair correlation was identified between lower PPT at the sacrum ($r = -0.384$, $p = 0.040$) and higher score on the McGill Pain Questionnaire Pain Rating Index total score. No other correlations reached statistical significance (Table 3).

4 Discussion

This study provides some insight into potential factors during pregnancy correlated with post-partum LPP, particularly by assessing sleep quality and pain sensitivity and difficulty performing the ASLR [6, 16]. In this group of women with low to moderate disability at baseline, a moderate to good correlation was found between poorer ASLR performance and poorer physical HRQoL, while a fair correlation was found between lower PPT in the sacrum and higher pain quality score. These exploratory findings may inform the development of larger prospective studies in pregnant women.

4.1 Strengths, considerations and limitations

Strengths of the study include the prospective design and the inclusion of novel measures (pressure pain sensitivity, sleep) known to be important from broader pain science that there is limited knowledge of in pregnancy-related LPP. All the measures can be applied in clinical practice.

There are a number of important considerations and limitations to understand when interpreting the results of this study though. Participants in this study reported low to moderate levels of pain and disability at baseline, which was further improved at follow-up. Future research could include a larger sample including more women with higher levels of pain and disability at baseline and follow-up to improve the external validity of these findings [11]. Additionally, post-partum LPP is known to be influenced by a combination of physical, psychological, and lifestyle factors [6, 19], but it was not within the power of this study to control for this given the number of participants recruited at baseline (we were unable to apply statistical methods to account for multiple comparisons).

Table 2: Baseline and follow-up variables of the participants who were included at follow-up.

	Whole sample post-partum $n=29$	Women with no pain post-partum $n=17$	Women with pain post-partum $n=12$
Pregnancy			
ASLR	2 (2.6)	2 (3)	2.8 (3)
PSQI	7 (5)	7 (5)	7.5 (3.5)
PPT (kPa)			
–Sacrum	314 (170)	338 (166)	257 (150)
–5th lumbar segment	291 (157)	285 154)	351 (174)
–Long dorsal ligament	315 (188)	355 (167)	297 (202)
–Gastrocnemius	337 (120)	332 (115)	353 (130)
–Deltoid	252 (85)	258 (80)	235 (78)
Post-partum[a]			
Pain intensity (NRS)	0 (1)	0 (0)	2 (1.5)
Pain quality (McGill)	4 (9)	0 (2)	8 (10.5)
Disability (PGQ)	0 (9)	0 (0)	10 (13.5)
Physical HRQoL (SF-36)[b]	55 (5)	56 (5)	54 (1)

ASLR = active straight leg raise; PSQI = Pittsburgh Sleep Quality Index; PPT = pain pressure threshold; NRS = numeric rating scale; McGill = McGill Pain Questionnaire Pain Rating Index total score; PGQ = Pelvic Girdle Questionnaire; HRQoL = health related quality of life; SF-36 = 36-item Short Form Health Survey. [a]All post-partum scores significantly. [b]Missing data from one participant who still had pain post-partum. Reported as median (interquartile range).

Participants' psychological profiles at baseline, were all within the normal range (Table 3) [20–22]. However, these were not re-examined at follow-up. Half the participants reported a previous history of LPP [23], which is another possible confounding factor. No follow-up physical examination occurred to determine if ongoing pain was attributable to a lumbar or pelvic-girdle source of symptoms. The definition of current pain intensity, while anchored in the broader questionnaire to the last week, may have been ambiguous in terms of the period it was referring to contributing to variability in individual responses. Future longitudinal research examining the predictive nature of these prognostic factors would need to control for confounding factors.

4.2 The ASLR as a prognostic factor for post-partum LPP intensity and quality, disability and HRQoL

The hypothesis that greater difficulty with performing the ASLR during pregnancy would correlate with reduced physical HRQoL post-partum was supported. This provides some further validation for the clinical utility of the ASLR during pregnancy, and is consistent with prior finding at 3 months post-partum using a non-body area specific measure of function [9]. Interestingly, the ASLR was not prognostic for pain intensity, pain quality or disability. The ASLR has previously been found to be prognostic for pain and disability in women who had pelvic girdle pain during

Table 3: Correlations (Spearman's ρ values) between baseline measures of the active straight leg raise, sleep quality and pressure pain thresholds with follow-up measures of pain intensity, pain quality, disability and physical health related quality of life ($n=28$).

	Pain intensity (NRS)	Pain quality (McGill)	Disability (PGQ)	Physical HRQoL[a] (SF-36)
Active straight leg raise	0.268	0.245	–0.031	–0.558[b]
Pittsburgh Sleep Quality Index	0.237	0.216	–0.089	–0.224
Pressure Pain Thresholds (kPa)				
–Sacrum	–0.283	–0.384[b]	–0.160	0.191
–5th lumbar segment	0.072	–0.160	0.006	–0.028
–Long dorsal ligament	–0.175	–0.311	–0.145	0.122
–Gastrocnemius	0.135	–0.211	0.001	0.061
–Deltoid	–0.080	–0.225	–0.068	0.326

NRS = numeric rating scale; McGill = McGill Pain Questionnaire Pain Rating Index total score; PGQ = Pelvic Girdle Questionnaire; HRQoL = Health Related Quality of Life; SF-36 = 36-item Short Form Health Survey. [a]$n=28$ due to SF-36 data missing for one participant. [b]Statistical significance $p<0.05$.

pregnancy, using the NRS and Oswestry Disability Index at 1 year [8]. However, Vollestad and Stuge (2009) used a sample where 60% of participants had an ASLR score ≥4/10, and logistic regression analysis found that a score ≥4 on the ASLR was prognostic for post-partum pain and disability. The sample in this current study had a median score of 2 on the ASLR (interquartile range 3.3), with only 34% of participants scoring ≥4/10. Consequently, sample differences may explain the different results between the two studies.

Questions in the 36-Item Short Form Health Survey for physical HRQoL [24] are not anchored to the experience of pain, which differs to those for region specific disability such as the PGQ [25] and the Oswestry Disability Index. As the ASLR is primarily an issue of heaviness of the leg rather than pain, HRQoL may therefore have greater fidelity for measuring the impact of LPP and poorer ASLR in groups of participants with lower levels of pain/disability than disability scales which are tied to the experience of pain (not heaviness of the leg).

Interestingly, our findings of the correlation between the ASLR and physical HRQoL at 11–18 months post-partum contrasts with the findings of Robinson et al. (2014), who reported that the ASLR was not a prognostic factor for physical HRQoL at 1 year post-partum for pelvic girdle pain. In that study, baseline scores for the ASLR test were not reported, but rather, participants were categorised as positive based on an ASLR score of greater than 0/10. This categorisation was justified based on previous research that indicated high specificity for this method of scoring the ASLR to identify LPP in pregnancy [18]. However, pain free individuals can rate the ASLR above 0/10 [16]. Given this, classifying the ASLR as positive in the manner of Robinson et al. (2014) may be an artificial categorisation. The lack of reported baseline average scores for the ASLR also make comparing the current findings with those of Robinson et al. (2014) difficult.

4.3 Sleep quality as a prognostic factor for post-partum LPP intensity and quality, disability and HRQoL

The hypothesis that poorer sleep quality during pregnancy would correlate with the follow-up variables, based on known relationships between pain sensitisation and sleep disturbance [17] and prior cross-sectional research in post-partum LPP [11], was not supported. This study used a sample of women with a median PSQI score of 7 out of 21 (interquartile range: 5.5). This is above the cut-off score of 5, which has been found to have high sensitivity and specificity to identify "good" versus "poor" sleepers [26]. However, some disturbance of sleep during pregnancy is to be expected [27], and it is not known if this cut-off value represents mild or significant sleep disturbance. More than 8 hours of sleep and rest each day during pregnancy has been associated with persistent LPP post-partum [23]. However, due to combining sleep and rest in that study, the contribution of sleep alone as a prognostic factor was unclear. Two cross-sectional studies on prognostic factors for LPP during pregnancy had differing results, with one finding an increased likelihood of low back related pain with lower hours of sleep each day [28], and the other finding no association [18]. However, the latter study used a 10-point scale to rate fatigue rather than a more detailed measure of sleep. A cross-sectional study on post-natal women found reduced sleep quantity and adequacy contributed to the presence of chronic post-partum LPP [11]. From previous research it appears poorer sleep quality may interact with LPP during and after pregnancy, but it was not prognostic for future pain in this study.

4.4 Pain sensitivity as a prognostic factor for post-partum LPP intensity and quality, disability and HRQoL

The hypothesis that pressure pain sensitivity during pregnancy would correlate with higher pain intensity and quality, higher disability and reduced physical HRQoL post-partum, was not entirely supported. The only significant finding was a fair correlation between PPT at the sacrum and subjective pain quality, suggesting that local pain sensitivity may have some prognostic value in post-partum LPP. This finding needs to be considered within the potential limitations of the study. However, that this finding related to pain quality (McGill Pain Questionnaire Pain Rating Index total score) rather than intensity, is of interest. The Pain Rating Index total score, based on pain descriptors, was utilised to provide information that would potentially align to individual experience of pain compared to simple ratings of intensity [29]. The contrasting findings for pain quality and pain intensity do suggest that consideration of the affective nature of pain could be important in future prognostic modelling.

Widespread pressure pain sensitivity was described in this cohort during pregnancy [10], but was not associated with either pain intensity or disability at follow-up. Another cross-sectional study during pregnancy has described widespread somatosensory sensitivity in participants with likely pelvic girdle pain compared to localised

sensitivity in those without pain [14]. The authors are unaware of any prospective studies assessing pain sensitivity during pregnancy as a prognostic factor for post-partum LPP.

There was not a significant correlation between PPTs and disability post-partum. This was consistent with a meta-analysis reporting little correlation between pain sensitivity and disability levels [30]. Potential relationships between pain sensitivity and disability require further research, as other aspects of patient presentation such as response to treatment strategies, could be mediated by pain sensitivity in the absence of a direct relationship between sensitivity and disability.

5 Conclusion

The results of this study indicate that pressure pain sensitivity and more difficulty with an ASLR may contribute to the prognosis of women with LPP during pregnancy. These explorative findings may be important for designing larger prognostic studies and may assist in directing potential pain management in post-partum LPP.

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Informed consent: All participants provided written informed consent at the time of entering the study covering collection of data at inclusion and follow-up.

Ethical approval: The study was approved by Curtin University's Human Research Ethics Committee (HR 210/2012) and followed the Helsinki declaration.

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