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Disturbed body perception, reduced sleep, and kinesiophobia in subjects with pregnancy-related persistent lumbopelvic pain and moderate levels of disability: An exploratory study

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ABSTRACT

Background: For a small but significant group, pregnancy-related lumbopelvic pain may become persistent. While multiple factors may contribute to disability in this group, previous studies have not investigated sleep impairments, body perception or mindfulness as potential factors associated with disability post-partum.

Objectives: To compare women experiencing no pain post-pregnancy with those experiencing pregnancy-related persistent lumbopelvic pain (either low- or high-level disability) across multiple biopsychosocial domains.

Design: Cross-sectional.

Methods: Participants completed questionnaires for thorough profiling of factors thought to be important in pregnancy-related lumbopelvic pain. Specific measures were the Urinary Distress Inventory, Medical Outcomes Study Sleep Scale, Back Beliefs Questionnaire, Tampa Scale for Kinesiophobia, Depression Anxiety Stress Scale, Coping Strategies Questionnaire, Pain Catastrophising Scale, The Fremantle Back Awareness Questionnaire and the Mindful Attention Awareness Scale. Women were categorised into three groups; pain free ($n = 26$), mild disability ($n = 12$) and moderate disability ($n = 12$) (based on Oswestry Disability Index scores). Non-parametric group comparisons were used to compare groups across the profiling variables.

Results: Differences were identified for kinesiophobia ($p = 0.03$), body perception ($p = 0.02$), sleep quantity ($p < 0.01$) and sleep adequacy ($p = 0.02$). Generally subjects in the moderate disability group had more negative findings for these variables.

Conclusion: Disturbances in body-perception, sleep and elevated kinesiophobia were found in pregnancy-related lumbopelvic pain subjects with moderate disability, factors previously linked to persistent low back pain. The cross-sectional nature of this study does not allow for identification of directional pathways between factors. The results support the consideration of these factors in the assessment and management of pregnancy-related lumbopelvic pain.

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1. Introduction

Musculoskeletal lumbopelvic pain (LPP) is common during pregnancy (Mogren and Pohjanen, 2005; Skaggs et al., 2007;

Mohseni-Bandpei et al., 2009; Kovacs et al., 2012; Pierce et al., 2012), with prevalence rates across pregnancy reported between 70 and 85%. It can have significant negative effects including disability (Gutke et al., 2006), work absenteeism (Stomp-van den Berg et al., 2012; Dorheim et al., 2013) and reduced health-related quality of life (Gutke et al., 2006; Robinson et al., 2006; Van De Pol et al., 2007). For most women pregnancy-related LPP is self-limiting, resolving within three months after delivery (Gutke et al., 2011; Robinson et al., 2014). However for 7–10% of women pain and disability become persistent with ongoing difficulties present two

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years post-partum (Albert et al., 2001; Wu et al., 2004; Rost et al., 2006).

For the vast majority of women with pregnancy-related, persistent LLP (PLPP) there is no evidence of specific patho-anatomical abnormalities and/or no specific disease process that can be identified with medically based diagnostic tests. Contemporary evidence suggests a broad biopsychosocial perspective is required to determine contributing factors to persistent pain and disability in these women (Albert et al., 2006; O'Sullivan and Beales, 2007a; Vleeming et al., 2008; Beales and O'Sullivan, 2011).

Pain features and psychological risk factors during pregnancy have been identified as being important in the development of PLPP post-pregnancy. In terms of pain features, high pain levels during pregnancy are prognostic for PLPP (Ostgaard et al., 1996) as are a higher number of positive pain provocation tests in the pelvic joints and greater number of pain sites (Albert et al., 2001; Robinson et al., 2010). In the psychological domain higher levels of distress (Albert et al., 2006; Bjelland et al., 2013), catastrophising (Olsson et al., 2012) and poor patient expectation of recovery (Vollestad and Stuge, 2009) have been identified as potential risk factors. However, these findings are not always consistent (Katonis et al., 2011). For example the importance of positive responses to clinical tests and the significance of pain locations has been questioned as poor post-partum recovery is not necessarily linked to these variables and may relate more to reduced adaptation to ongoing symptoms (Robinson et al., 2014). However in another study high psychological distress was not found to be a prognostic factor for pregnancy-related PLPP (Vollestad and Stuge, 2009).

Profiling of women post-partum who are experiencing PLPP further highlights the biopsychosocial nature of these pain disorders. In terms of pain features, pain intensity has been correlated to higher levels of disability in PLPP (Gutke et al., 2011) as has positive pain provocation testing (Ronchetti et al., 2008; Mukkannavar et al., 2014). In the psychological domain depression (Gutke et al., 2007) can be a feature of pregnancy-related PLPP, and kinesiophobia has been documented as a potential contributor (Gutke et al., 2011).

Additional factors associated with persistence of musculoskeletal pain may also be important in pregnancy-related PLPP. There is strong evidence for links between sleep impairment and other pain disorders such as spinal pain, headaches and fibromyalgia (Menefee et al., 2000; Finan et al., 2013), however the relationship between sleep and PLPP has not yet been fully established. While insomnia in pregnancy has been associated with the presence of LPP during pregnancy (Dorheim et al., 2012), this relationship has not been investigated in relation to PLPP. Another study reported that more than 8 h sleep or rest at 30 weeks of pregnancy was associated with ongoing pain at 12 weeks post-partum (Stomp-van den Berg et al., 2012), although this study did not differentiate sleep from rest. Another factor gaining recognition as a potential contributor to pain disorders is disrupted body perception, which has been associated with low back pain (Wand et al., 2011, 2014). Altered body perception is thought to be linked to motor control changes in low back pain (Luomajoki and Moseley, 2011; Wand et al., 2011), and a similar relationship may be applicable to pregnancy-related PLPP where motor control changes have been linked to these disorders (O'Sullivan et al., 2002; Pool-Goudzwaard et al., 2005; Beales et al., 2009). Also a mismatch between the real and virtual body has been proposed as a mechanism for enhancing pain perception (Wand et al., 2014). It is logical that altered body perception may be a factor in PLPP given the relatively rapid changes in body shape during pregnancy and following delivery, and the common clinical reports of 'pelvic asymmetry' associated with the disorder (Lee et al., 2008; Al-Sayegh et al., 2010). Mindfulness is another factor that has been associated with chronic pain, with a significant relationship with pain catastrophising (Schutze

et al., 2010). Mindfulness could potentially be protective against PLPP. To our knowledge associations between body perception, mindfulness and pregnancy-related PLPP have not been previously investigated.

Therefore this study investigated whether women with high versus low levels of disability associated with pregnancy-related PLPP differed from pain-free postpartum controls on sleep, body perception, and mindfulness. Additionally, we aimed to evaluate group differences for previously identified factors that may contribute to ongoing pain and disability postpartum (pain levels, urogenital comorbidities, beliefs, psychological distress, kinesiophobia, catastrophising, coping strategies). Delineation by high or low levels of disability was carried out in order to clarify previous findings related to factors contributing to disability behaviours in PLPP. It was hypothesized that women with higher levels of disability associated with pregnancy-related PLPP would present with more negative beliefs, high levels of distress, fear and catastrophising, poorer coping, poorer sleep, altered body perception and reduced mindfulness compared to those with lower disability and without pain.

2. Methods

2.1. Subjects

For this cross-sectional questionnaire based study we recruited subjects from three physiotherapy outpatient clinics in Perth, Western Australia. Women were included if they were greater than or equal to 3 months postpartum. Women were recruited into two groups; a pain free group, and those with PLLP that originated during pregnancy or within 3 weeks postpartum (Ronchetti et al., 2008). The pain area was defined posteriorly from the below the 12th ribs to the gluteal folds and included the anterior pelvis (Chang et al., 2013). Sufficient comprehension of written English language was required. Participant could not be presently pregnant or were excluded if they had a neurological disorder. Curtin University Human Research Ethics Committee granted ethical approval (Approval Number PT0159).

2.2. Measures

Participants completed a written questionnaire for thorough profiling of factors thought to be important in pregnancy-related PLPP. The questionnaire included demographic data (see Table 1 for included variables) and a number of valid and reliable questionnaires for examining disability, pain and a number of psychological domains. Disability was obtained from the Oswestry Disability Index (ODI) (Fairbank et al., 1980), a commonly used region specific disability measures (Chapman et al., 2011) allowing designation between levels of disability. Given the known complex relationships between pain and disability (Briggs et al., 2010), pain was assessed with the descriptor component of the Short-Form McGill Pain Questionnaire (Melzack, 1987). The presence of urogenital comorbidities, known to be comorbid with PGP (Pool-Goudzwaard et al., 2005), was assessed with the Urogenital Distress Inventory (UDI) (Uebersax et al., 1995). Beliefs related to the future consequence and inevitability of back pain were assessed with the Back Beliefs Questionnaire (BBQ) (Symonds et al., 1996), given the potential for beliefs to drive disability as well as pain (Briggs et al., 2010). For this project the term 'low back' in the BBQ was altered to 'low back/pelvic girdle' to reflect the area of symptoms involved with the label of LPP. This alteration in the questionnaire has reasonable face validity (Beales and O'Sullivan, 2014). The Tampa Scale for Kinesiophobia (TSK) (Vlaeyen et al., 1995) was utilised as a measure of pain-related fear. The Depression, Anxiety

Table 1
Demographic data reported as median (interquartile range) (Significant findings $p < .05$ in bold).

	Pain free $n = 26$	Low disability $n = 12$	Moderate disability $n = 12$	p
Age (years)	32 (28–36)	35 (32–36)	35 (32–37)	.26
Height (cm)	168 (165–172)	171 (168–175)	167 (163–174)	.31
Weight (kg)	65 (58–74)	73 (55–82)	68 (60–79)	.69
Marital Status				
- Married/DeFacto	25	11	12	
- Single	1	1	–	
Highest Education				
- High School	4	–	4	
- Tertiary	22	12	8	
Number of Children				
- 1	23	5	6	
- 2	1	5	2	
- 3	1	2	4	
- 4	1	–	–	
Childs Age (months) ^a	4 ^c (3.6–5)	14 (5.8–20.5)	8.2 (5.6–16.2)	<.01
Childs Birth Weight (kg) ^b	3.3 (3.0–3.7)	3.4 (3.1–3.6)	3.5 (3.3–3.9)	.67

^a Childs age is a marker for duration of symptoms in the disability groups.

^b Refers to most recent child's birth weigh. In the low disability group there were two sets of twins for whom combined birth weight was used.

^c Pain free group significantly different from both disability groups.

Stress Scales (DASS) (Page et al., 2007) was used to assess mood and the Pain Catastrophising Scale (PCS) (Sullivan et al., 1995) for catastrophising constructs of rumination, magnification and helplessness. The Coping Strategies Questionnaire-Revised (CSQ-R) (Riley et al., 1999) was used to assess six different cognitive coping strategies and two behavioural strategies. This group of psychologically based questionnaires, with known associations with LPP, were included to provide insight into the psychological drivers of disability.

The Fremantle Back Awareness Questionnaire (FreBAQ) (Wand et al., 2014) has been developed as a questionnaire based assessment of altered body perception specific to the back. It was included based on previous findings in subjects with disabling back pain (Wand et al., 2014) and the potential for body changes associated with pregnancy to alter body perception. As per the BBQ, the term 'back' in the FreBAQ was altered to 'back/pelvis' to be more specific to the area of symptoms associated with LPP. The specific validity of this alteration has not been established. The Mindful Attention Awareness Scale (MAAS) (Brown and Ryan, 2003) was used to assess mindfulness according to day-to-day experience, and has been utilised as an overall measure of mindfulness. It has been reported as a potential contributing factor and target for management in low back pain, that may also be important for PLPP. Potentially, women with higher levels of fear and distress and poorer coping mechanisms may have reduced mindfulness. Lastly, sleep was assessed with the Medical Outcomes Study Sleep Scale (MOS Sleep Scale) (Spritzer and Hays, 2003). Poor sleep is known to contribute to pain sensitivity, is frequently disrupted in the early maternal stages, and therefore may be a factor in both pain and disability levels. The MOS Sleep Scale is a patient-reported, non-disease-specific instrument for evaluating multiple aspects of sleep impairment.

The ODI, Short-Form McGill Pain Questionnaire and TSK were not obtained from the pain free subjects as the inclusion criteria dictated that these subjects were pain free, so these questionnaires were not deemed appropriate for those subjects to complete.

2.3. Analysis

As per the aim of the study, three subject groups were compiled from the subjects recruited for the study. One comprised of the pain-free subjects. The pregnancy-related PLPP subjects were split into two groups based on the level of disability. The split was made by performing a median split using ODI scores (Briggs et al., 2010).

Statistical analysis was performed with the 'R' statistical package (Version 3.0.0, GUI 1.60, Snow Leopard build (6476), R Foundation for Statistical Computing). Non-parametric analyses were performed based on non-normal distribution of the data. For the majority of the variables three-group (pain free, pregnancy-related PLPP at two levels of disability) comparisons were made with Kruskal–Wallis Rank Sum analysis using Wilcoxon Rank Sum analysis for post-hoc inter-group comparisons. Two-group comparisons were made with Wilcoxon Rank Sum analysis for the ODI, Short-Form McGill Pain Questionnaire and TSK. Significance value was set at .05.

3. Results

Twenty-six women were recruited to the pain free group. Twenty-four women with pregnancy-related PLPP were recruited. After the median split was performed 12 subjects were allocated to a low disability group and 12 to a moderate disability group. The labelling of these groups as low and moderate disability is consistent with established categorisation of ODI scores (Fairbank et al., 1980), based on the actual ODI scores for pregnancy-related PLPP subjects after the median split was performed (Table 2).

Demographic characteristics of the participants are shown in Table 1. The child's age variable acted as a marker of the length of time participants in the low and moderate disability groups had experienced symptoms. While there was a difference between the child's age between the pain free subjects and those with pregnancy-related PLPP, there was no statistically significant difference for this variable between the low and moderate disability categories ($p = 0.44$). Additionally 11 of the 26 pain-free subjects reported that they had experienced LPP during pregnancy but this had subsided post-partum. Given such a split post-hoc comparison was made between those in the pain-free group who had and hadn't experienced pain, but no statistically significant differences were identified.

One pain free person failed to complete the DASS appropriately and another failed to complete the Fremantle Back Awareness Questionnaire. Two pain free people failed to answer the CSQ-R behavioural strategies questions.

Table 2 presents the results for the majority of the profiling variables. As per the disability categorization to low and moderate disability groups, the ODI scores were significantly different in these pregnancy-related PLPP groups. The TSK for the moderate disability group was higher than the low disability group (Table 2)

Table 2
Group comparisons reported as median (interquartile range) (Significant $p < .05$ in bold).

	Pain free n = 26	Low disability n = 12	Moderate disability n = 12	p^a
Oswestry Disability Index	–	8 (6–14)	26.0 (22.0–35.5)	<.01
Short Form McGill Pain Questionnaire	–	12.5 (8.8–20.5)	18.5 (15.5–27.8)	.15
Urinary Distress Index	5.6 (0–11.1)	11.1 (4.1–19.4)	5.6 (0–12.5)	.33
Back Beliefs Questionnaire	29.0 (26.0–32.0)	30.5 (29.8–33.8)	28.5 (24.2–29.2)	.06
Tampa Scale for Kinesiophobia	–	35.0 (30.0–37.2)	39.0 (36.0–42.5)	.03
DASS ^b				
- Depression	1 (0–2.0)	0 (0–4.0)	2.5 (0–9.2)	.33
- Anxiety	1 (0–2.0)	1.5 (0–4.2)	2.5 (0.8–7.2)	.26
- Stress	6 (1.0–10.0)	6.5 (1.8–10.2)	8.5 (5.0–16.5)	.20
Pain Catastrophising Scale ^b				
- Rumination	3.0 (0–5.0)	1.0 (0–2.2)	3.5 (1.8–9.0)	.17
- Magnification	1.0 (0–2.0)	0 (0–1.5)	1.0 (0.8–2.2)	.38
- Helplessness	1.0 (0–5.0)	3 (1.8–4.2)	5.5 (1.0–9.2)	.20
Coping Strategies				
- Distraction	2.3 (0.9–2.9)	1.2 (0.3–2.6)	1.2 (0.4–2.0)	.32
- Catastrophising	0.6 (0.3–1.3)	0.6 (0.4–1.0)	1.1 (0.7–2.8)	.15
- Ignoring	3.0 (2.2–3.4)	2.7 (1.9–3.6)	2.8 (1.6–3.9)	.97
- Distancing	0.4 (0–1.6)	0.4 (0–0.8)	0 (0–1.7)	.72
- Coping Self Statement	4.1 (3.1–5.0)	3.5 (2.9–4.2)	4.4 (3.4–4.8)	.63
- Praying	0 (0–2.0)	0 (0–0)	0 (0–0.5)	.21
- Overall Control ^c	3.5 (3.0–5.0)	3.0 (3.0–5.0)	3.0 (2.5–4.2)	.61
- Ability Decrease ^c	3.5 (3.0–4.0)	3.0 (2.8–4.2)	3.0 (1.5–3.2)	.13
Fremantle Back Awareness ^b	2.0 (0–6.0)	6.5 (3.0–8.5)	8.0 ^d (6.5–11.0)	.02
Mindful Attention Awareness Scale	60.0 (49.2–71.5)	60.0 (49.8–72.0)	55.0 (48.0–67.2)	.67

^a p value for main effects.

^b For pain free group $n = 25$.

^c For pain free group $n = 24$.

^d Moderate disability differs from pain free in post-hoc analysis (Fremantle Back Awareness $p = 0.01$).

consistent with higher levels of kinesiophobia. The score for the FreBAQ was higher in the moderate disability group than the pain free group (Table 2), suggesting a higher level of body perception distortion in this group.

Table 3 shows the results of the MOS Sleep Scale. Differences were identified between the three groups for sleep quantity with the moderate disability group reporting the least number of hours sleep (median = 6 h) compared with the no pain (median 6.75 h) and low disability (median = 7 h) groups. Consistent with this, sleep adequacy was lower in the moderate disability group compared to the pain free subjects (Table 3).

4. Discussion

This study profiled women with pregnancy-related PLPP with low and moderate levels of disability across a broad spectrum of factors, and compared them to pain free post-partum women. Greater levels of kinesiophobia were found in subjects with pregnancy-related PLPP and moderate disability compared to those with low levels of disability. Disturbance of body perception was found in those with moderate disability due to pregnancy-related PLPP compared to those who were pain free post-partum. Furthermore sleep impairment related to quantity and adequacy

of sleep was identified in those subjects with moderate disability. Differences were not identified for any other variables (Table 2). While the results require confirmation in larger studies and with prospective design, the findings provide insight into potentially important factors previously not investigated in relationship to pregnancy-related PLPP (ie. body perception and sleep).

4.1. Psychological factors

The TSK was the only psychological factor that reached significance in this study. A score above 37 has been described to represent high levels of kinesiophobia (Vlaeyen et al., 1995), and was observed in the moderate disability group. Kinesiophobia has previously been reported as a factor associated with higher levels of disability in a group of women with LPP 3 months post-partum (Gutke et al., 2011), however in that study the contribution of kinesiophobia to disability was less than pain intensity. It would appear that kinesiophobia should be considered as a potential contributing factor to higher levels of disability in pregnancy-related PLPP. This is logical given that kinesiophobia may relate to beliefs that pain is a sign of damage or threat (Bunzli et al., 2014), relating to avoidance of activities and exercise (Rainville et al., 2011; Vlaeyen and Linton, 2012; Bunzli et al., 2014). Consistent with this

Table 3
Sleep variables from the Medical Outcomes Study Sleep Scale reported as median (interquartile range) (Significant $p < .05$ in bold).

	Pain free n = 26	Low disability n = 12	Moderate disability n = 12	p^c
Sleep Problem Index II	32.5 (24.4–45.3)	36.9 (30.6–41.5)	48.9 (35.0–61.0)	.06
Sleep Quantity	6.75 (6–7)	7 (6.9–8.0)	6 ^{a,b} (6–6)	<.01
Sleep Disturbance	20.6 (10.3–35.0)	28.8 (18.8–35.3)	47.5 (23.8–65.3)	.10
Snoring	0 (0–20.0)	0 (0–20.0)	0 (0–20.0)	.99
Sleep Short of Breath/Headache	1 (0–15.0)	0 (0–20.0)	0 (0–20.0)	.84
Sleep Adequacy	50.0 (40.0–50.0)	35.0 (27.5–55.0)	25.0 ^d (0–42.5)	.02
Sleep Somnolence	26.7 (20.0–33.3)	30.0 (20.0–40.0)	40.0 (26.7–46.7)	.29

^a Moderate disability differs from pain free in post-hoc analysis (Sleep Quantity $p < 0.01$, Sleep Adequacy $p < 0.01$).

^b Moderate disability differs from mild disability in post-hoc analysis (Sleep Quantity $p = 0.03$).

^c p value for main effects.

there was a trend for more negative beliefs in the 'moderate' disability group (lower BBQ score, [Table 2](#)) that could underlie kinesiophobia. Alternately, fear may relate to beliefs that painful activities will lead to increased suffering or functional loss and contribute to disability in that manner. Further investigation into the basis of kinesiophobia needs to identify the specific underlying beliefs associated with fear specific to women with pregnancy related PLPP in order to facilitate meaningful intervention strategies.

Other variables in the psychological domain did not reach statistical significance ([Table 2](#)). This may be an artifact of the power of the study in relationship to those variables. On the other hand it may be that many of the psychological factors we examined in this study may be more significantly related to pregnancy-related PLPP with higher levels of disability than those recruited to this study. This is consistent with the variability in the literature with regard to the relationship between psychological factors and pregnancy-related PLPP ([Katonis et al., 2011](#)). We specifically included a measure of mindfulness as this does not appear to have been previously investigated in PLPP. That mindfulness did not differ across the three groups may be consistent with not finding differences related to psychological affect (DASS, PCS) given established correlation between mindfulness and aspects of affect ([Brown and Ryan, 2003](#); [Schutze et al., 2010](#)).

Given overall evidence for the role that psychological factors in PLPP, routine screening in the clinical evaluation of PLPP patients may be advisable, especially in those with high levels of disability ([Linton and Hallden, 1998](#); [Hill et al., 2008](#)). This is supported by indications that physiotherapists may not recognise/prioritise psychological management in patients with pregnancy-related LPP ([Beales et al., 2015](#)). Further research in this area is warranted.

4.2. Body perception

Altered body perception has been recognised as a potential impairment associated with chronic low back pain ([Wand et al., 2011](#)) that could reasonably impact clinical outcomes ([Wand et al., 2014](#)). Further research using objective measures of body image representation would be useful to expand on our finding of altered body perception in subjects with moderate disability via the self-reported FreBAQ. It is unclear whether altered body perception is a biomarker of pain behaviours and/or a central driving feature of behaviour. Changes in body shape and composition during pregnancy and post-partum may reasonably be a factor in changing body perception in women. There is some evidence of changes in body schema during pregnancy ([Ruggieri et al., 1979](#); [Tiemersma, 1989](#)), which may be related to changes in body perception ([Burritt and Fawcett, 1980](#)). However this alone does not explain why altered body perception was associated with disability levels. One possibility is that changes in the body are linked to fear orientated thoughts about pain and movement (in post hoc analysis the correlation between TSK and FreBAQ was .43, supporting this notion). Further examination of body perception longitudinally through pregnancy would provide additional insight into changes in body perception, particularly in relationship to the development and maintenance of LPP. Previous research has demonstrated changes to body schema with weight loss in anorexia nervosa ([Guardia et al., 2012](#)), hypothesized to be linked to cortical changes in the somatosensory and parietal regions of the brain. While speculative similar mechanisms may occur in relation to pregnancy and persistent pain. From a clinical perspective, our findings suggest consideration of body perception may be important in the assessment of women with LPP both during pregnancy and post-partum.

While speculative, altered body perception may be associated with common clinical reports of pelvic asymmetries ([Lee et al., 2008](#)). In the lumbar spine altered body perception has been indicated by subjects with low back pain depicting their lumbar vertebrae to be displaced from the mid-line. This measure of altered body perception has been associated with reduced acuity of two-point discrimination in the same region ([Moseley, 2008](#)). Similar processes may underlie subjective reports of pelvic asymmetries. Evidence for pelvic asymmetries is poor ([Tullberg et al., 1998](#)), and mistaken patient beliefs related to pelvic asymmetries and instability have been proposed to represent a pathway to kinesiophobia, avoidance and reliance on passive care ([Beales and O'Sullivan, 2011](#); [O'Sullivan and Beales, 2007a, b](#)). Future investigation of the relationship between these factors to clarify these relationships is warranted.

4.3. Sleep

It has been suggested sleep impairment is a greater contributor to persistent pain, than pain driving sleep impairment ([Finan et al., 2013](#)). A significant reason for this relates to disruption of the restorative power of sleep ([Shapiro and Flanagan, 1993](#); [Dang-Vu et al., 2006](#)). Sleep impairment both during pregnancy and post-partum is well established ([Dzaja et al., 2005](#); [McBean and Montgomery-Downs, 2013](#)). The pain free subjects in this study were a median of 4 months post partum, and thus at a time point when sleep impairment is likely secondary to caring for a newborn. It is telling then that pregnancy-related PLPP subjects with moderate disability, for whom the median child's age was 8.2 months ([Table 1](#)), still had significant sleep impairments in terms of quantity and adequacy compared to pain free subjects ([Table 3](#)). Sleep impairments are known to contribute to heightened pain sensitivity ([Schuh-Hofer et al., 2013](#)) and emerging research has highlighted a relationship between pain sensitivity, sacroiliac joint pain provocation tests and the active straight leg raise test ([Palsson and Graven-Nielsen, 2012](#); [Palsson et al., 2014](#)). Thus tissue sensitivity measured by pain provocation tests/positive active straight leg raise may present a link between sleep impairment and disability. Further research into the relationship between sleep impairment and pregnancy-related PLPP should consider both subjective and objective measures of sleep, as they measure different aspects of sleep ([O'Donoghue et al., 2009](#)). Given our findings, assessing and addressing sleep impairment should be considered in patients with pregnancy-related PLPP associated with moderate disability.

5. Conclusion

The results of this study provide preliminary evidence for a relationship between higher levels of kinesiophobia, altered body perception and sleep impairment in subjects with pregnancy-related PLPP who have moderate disability. Additionally the results of this study may be useful to assist clinicians in improving understanding of the biopsychosocial presentation of women with pregnancy-related LPP. Future investigation is warranted to clarify the relationships identified in this study, utilising larger cohorts and prospective designs.

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