2017

Disrupted body-image and pregnancy-related lumbopelvic pain. A preliminary investigation

B Wand
The University of Notre Dame Australia, benedict.wand@nd.edu.au

R Elliott

A Sawyer

R Spence

D Beales

See next page for additional authors

This article was originally published as:
Wand, B., Elliott, R., Sawyer, A., Spence, R., Beales, D., O'Sullivan, P., Smith, A., & Gibson, W. (2017). Disrupted body-image and pregnancy-related lumbopelvic pain. A preliminary investigation. *Musculoskeletal Science and Practice, 30*, 49-55.

Original article available here:
http://dx.doi.org/10.1016/j.msksp.2017.05.003

Authors
B Wand, R Elliott, A Sawyer, R Spence, D Beales, P O'Sullivan, A Smith, and W Gibson

This is the author's post-print copy of the article published as:

Wand, B., Elliott, R., Sawyer, A., Spence, R., Beales, D., O'Sullivan, P., Smith, A., and Gibson, W. (2017) Disrupted body-image and pregnancy-related lumbopelvic pain. A preliminary investigation. *Musculoskeletal Science and Practice, 30,* 49-55. doi: 10.1016/j.msksp.2017.05.003

This article has been published in final form at http://dx.doi.org/10.1016/j.msksp.2017.05.003

Title: Disrupted body-image and pregnancy-related lumbopelvic pain. A preliminary investigation

Authors:

Benedict M Wand.[1]

Rhianne L Elliott.[2]

Abbey E Sawyer.[3]

Rory Spence.[4]

Darren J Beales.[5]

Peter B O'Sullivan.[5]

Anne J Smith.[5]

William Gibson.[1]

[1]School of Physiotherapy, The University of Notre Dame Australia, 19 Mouat St, Fremantle, WA 6959, Australia.

[2]Central West Health and Rehabilitation, Urch St, Geraldton, WA 6530, Australia.

[3]Physiotherapy Department, Sir Charles Gairdner Hospital, Hospital Ave, Nedlands, WA 6009, Australia.

[4]RediMed Total Health Solutions, 1 Frederick Street, Belmont, WA 6104, Australia.

[5]School of Physiotherapy and Exercise Science, Curtin University, PO Box U1987, Perth, WA 6845, Australia.

Attribute to:

School of Physiotherapy,

The University of Notre Dame Australia

19 Mouat Street, Fremantle

WA 6959, Australia.

Correspondence to:

Dr Benedict M Wand,

School of Physiotherapy,

The University of Notre Dame Australia

19 Mouat Street, Fremantle

WA 6959, Australia.

T: +61 8 9433 0203

F: +61 8 9422 0566

E: benedict.wand@nd.edu.au

ABSTRACT

Background.

Recent investigations have suggested that disrupted body-image may contribute to the lumbopelvic pain experience. The changes in body shape and size associated with pregnancy suggest that pregnancy-related lumbopelvic pain might be a problem in which alterations in body-image are particularly relevant.

Objectives

To investigate if self-reported body-image is related to lumbopelvic pain status in women during pregnancy and explore the factors that might contribute to changes in body-image in women experiencing pregnancy-related lumbopelvic pain.

Design.

Cross-sectional cohort study.

Method

Forty-two women in the third trimester of pregnancy were recruited regardless of clinical status. Pain intensity and disability were measured to estimate clinical severity. The Fremantle Back Awareness Questionnaire was used to assess body-image. Participants also completed a series of questionnaires and physical tests to explore factors that might be associated with altered body-image.

Results

The median Fremantle Back Awareness Questionnaire score for the pain free women was 1 (IQR 0-1.5) and the median score for those in pain was 3.5 (IQR 2-8). This difference was

statistically significant (p=0.005). The questionnaire score was significantly correlated with pain intensity but not with disability. Of the measured variables only pain catastrophisation was significantly associated with disrupted body-image.

Conclusions

Self-reported disruption of body-image was significantly greater in pregnant women who were experiencing lumbopelvic pain than those who weren't and the extent of body-image disruption was associated with pain intensity. Only pain related catastrophisation was related to disrupted body-image.

KEYWORDS

Pregnancy; lumbopelvic pain; body-image; body-schema

INTRODUCTION

Lumbopelvic pain (LPP) is common during pregnancy with up to 85% of women reporting pain during the third trimester [1]. The burden of LPP during pregnancy includes time off work, functional loss and reduced quality of life [2, 3]. Furthermore, while the majority of women recover soon after delivery [4], a significant number continue to experience problems for many years post-partum [5].

It is now well established that the pain and disability experienced by women with pregnancy-related LPP are influenced by multiple elements [6, 7]. Numerous biological, psychological and lifestyle factors have been shown to contribute to the problem [1, 8-13], though much variance is unexplained, suggesting other issues require consideration. For low back pain (LBP) in general there has been recent interest in the role that altered body-image that is, the way the body feels to the individual [14], might play in the pain experience [14-16]. There is evidence of reorganisation [17-22] as well as morphological [23-30] and biochemical changes [31, 32] in areas of the brain thought to subserve body-image. Several studies have reported that people with LBP perceive the back as fragile and vulnerable [33-35], feel a sense of alienation and rejection of the back [36-38], represent the back differently when asked to draw how the back feels to them [39, 40] and endorse questionnaire items associated with altered perceptual awareness of the back [16, 41, 42]. Furthermore, psychophysical findings consistent with disruption of the mechanisms that underpin body-image [43] such as decreased tactile acuity [44], problems localising sensory input [45], greater lumbar repositioning error [46], poor trunk motor imagery performance [47, 48] and impaired visual recognition of actions [49, 50] also appear to be features of chronic LBP. Moreover, there are some data to indicate that strategies designed to improve body-image might improve clinical status [51-57].

The changes in body shape and size associated with pregnancy suggest that pregnancy-related LPP might be a problem in which alterations in body-image are particularly relevant. The Fremantle Back Awareness Questionnaire (FreBAQ), a quick and simple tool for assessing perceptual awareness of the lumbopelvic region has been recently developed [41] and appears to have good psychometric properties [16]. In a recent investigation, scores on the FreBAQ were shown to be significantly higher in women with post-partum LPP and moderate disability compared to women who were pain free post-partum [58]. Given this finding in the post-partum population, we were interested in exploring if altered body-image of the lumbopelvic region during pregnancy was related to clinical status.

The primary aim of this study was to investigate if self-reported body-image, as assessed by the FreBAQ, is related to clinical status in women in the third trimester of pregnancy. Specifically we investigated if body-image differs between participants who report LPP and those who don't, and for those who do report LPP does the degree of altered perception relate to clinical severity. A secondary question was to investigate what factors might contribute to altered body-image in LPP pain by exploring the relationship between body-image and pain related cognition, body satisfaction, local tissue sensitivity and clinical measures of body-schema.

METHODS

Design

We undertook an exploratory, observational cross-sectional study of women in the third trimester of pregnancy. The study was approved by the Institutional Human Research Ethics

Committee. All participants provided signed, informed consent and all procedures conformed to the declaration of Helsinki.

Participants

Between February and July 2014 a convenience sample of forty-two participants were recruited, irrespective of pain status, from pre-natal exercise classes and local community contacts. Participants were considered eligible if they were within their third trimester of pregnancy, were aged between 18 and 45, were fluent in written and spoken English and were otherwise healthy. Participants were excluded if they reported any significant extant medical or psychiatric condition, were taking any centrally acting medication, had a significant uncorrected visual impairment, were over 38-weeks pregnant or if they had experienced LPP sufficient to restrict work or leisure within the 6-months prior to the current pregnancy.

Procedure

On the day of testing eligible participants were presented with detailed information regarding the project and signed a consent form. All participants supplied basic demographic information, had their height and weight measured and provided information on previous LPP. Pregnancy-related details were collected including pregnancy number, week of gestation and fundal height. Participants were asked to indicate if they had experienced any LPP since week 28 of the current pregnancy and record on a body chart where the pain was distributed. Lumbopelvic pain intensity was recorded as the average of three numerical rating scales (NRS) anchored 0='no pain' and 10='pain as bad as you can imagine' for i) worst pain over the last week, ii) average pain over the last week and iii) present pain, yielding a score out of 10 [59]. LPP related disability was estimated using the Pelvic Girdle Questionnaire (PGQ) [60]. Self-reported body-image of the lumbopelvic region was evaluated using the FreBAQ [16]. Participants were instructed that the questions should be answered in reference to the lumbopelvic region as a whole and modifications were made to the instructions to account for pain free participants [41].

Participants next completed a variety of standardised surveys and physical tests. The questionnaires were completed first, and after a brief rest the physical tests were performed in the same order. All participants completed all testing though only data from women reporting LPP were used for further analyses. The participants were instructed not to inform the tester of their pain status and questionnaire scores were not viewed until after completion of all physical tests to ensure the tester was blinded to pain status and to the pain and disability scores.

Questionnaires

The level of pain-related catastrophisation was measured using the Pain Catastrophizing Scale (PCS) [61], pain-related fear was estimated using the Tampa Scale of Kinesiophobia (TSK) [62] and the Back Beliefs Questionnaire (BBQ) [63] was used to assess beliefs regarding the inevitability and future consequences of LPP, for this questionnaire 'back/pelvic girdle trouble' was substituted for 'back trouble' [58]. The Body Area Satisfaction Scale (BASS), a subscale of the Multidimensional Body-Self Relations Questionnaire [64 1990], was used to evaluate body satisfaction. We utilised only two of the nine items, item 63: satisfaction or dissatisfaction with the lower torso (buttocks, hips, thighs, legs) and item 64: satisfaction or dissatisfaction with the mid torso (waist, stomach). The scores from the two items were averaged for analysis [65].

Physical tests

One measure was undertaken to assess tactile acuity, a factor likely to contribute to the integrity of the representational body-schema. A set of mechanical callipers with precision of 1mm (Lafayette two-point aesthesiometer, Lafayette Instruments, Lafayette, IN, USA) were used to assess vertical two-point discrimination (TPD) threshold over the lumbopelvic region. Participants were positioned in a seated position leaning on a table in front of them to ensure that the lumbar spine remained as flat as possible. The assessor marked the left and right posterior superior iliac spines (PSIS) which served as the centre point for all testing.

The aesthesiometer was applied to the back three consecutive times at each calliper distance and participants were instructed to indicate whether they could feel 'one' or 'two' points. Two ascending and two descending runs were performed for each side, in random order and a threshold value obtained for each run. The mean of the eight threshold scores provided an average TPD value for the lumbopelvic region.

One measure was undertaken to assess laterality recognition, a factor likely to contribute to the integrity of the postural body-schema. The '*Recognise*' Application (Neuro Orthopaedic Institute, Adelaide, Australia) run on a tablet device was used to assess lumbar left/right judgement accuracy. Participants were positioned at a desk with the tablet flat on the table in front and centred to the person's midline. Pictures of a model bent or rotated to either the left or right were displayed for a maximum of 10 seconds and participants were instructed to as quickly and accurately as possible select either the 'left' or 'right' button, depending on which way they thought the person in the picture was moving. Twenty practice images were first undertaken, the results of which were not recorded. Following the practice trial participants completed two sets of forty images with a two minute rest between sets. An accuracy score was calculated as the percentage correct for these 80 images [47].

Sensitivity to punctate pressure was assessed immediately inferior to the PSIS bilaterally. A disposable single-use Medipin (Medipin Limited, Hertfordshire, UK) was used to provide five repeated stimuli at a frequency of 1Hz. Immediately on completion participants were asked to indicate the level of pain they perceived during the five stimulations using a NRS. An average of the scores from each side were used for analysis.

Temporal summation to repeated punctate stimulation was also evaluated. After the initial five stimuli subjects rested for 20 seconds and then the stimuli were re-presented at a rate of 1 Hz for 30 seconds. The participants rated the level of pain they perceived during the last five stimuli. An index of temporal summation was obtained by subtracting the pain rating from the last five stimuli from the pain rating given for the initial five stimuli [66]. Testing was undertaken bilaterally in random order and the average of the two sides used for analysis. Participants whose pain rating was >7/10 after the initial five stimuli were not assessed for temporal summation.

Data Analysis

The study was regarded as a pilot investigation and no formal power calculation was undertaken. All analyses were undertaken using Stata/IC 14.1 for Windows (StataCorp LP, College Station TX, USA). Data were inspected for normality and data transformation undertaken where appropriate. Descriptive statistics were used to present demographic information for the whole sample and describe clinical status of those participants reporting LPP.

Differences in pain intensity, disability and log-transformed FreBAQ scores between participants with low back pain only, pelvic girdle pain and both lumbar and pelvic girdle pain were explored using a one way ANOVA. Difference in FreBAQ scores between LPP and no LPP participants were assessed using the non-parametric Mann-Whitney U-test. Pearson's correlation was used to assess the association and other measured variables in those participants with LPP, log-transformed as necessary (PCS and lumbar punctate sensitivity).

RESULTS

Forty-three volunteers contacted the researchers of whom one did not meet eligibility criteria. Forty-two women completed the study. Due to a technical problem the left/right judgement data for one participant was not recorded and the initial punctate pain sensitivity testing was rated over 7/10 in one participant, so temporal summation was not assessed, there were no other missing data. Nineteen (45%) participants had experienced previous LPP, whilst 23 (55%) had not. Eight (19%) participants had no current LPP and 34 (81%) were currently experiencing LPP.

Of the 34 participants reporting LPP, five recorded their pain as only lumbar, eight as only pelvic girdle and 21 as both lumbar and pelvic girdle. We found no difference in pain intensity, disability or FreBAQ scores across these three groups (data not shown) and all data were combined for further analysis. Demographic and pregnancy related details for the whole sample can be found in Table 1.

TABLE 1. Demographic and pregnancy related characteristics of the whole sample (n=42)

Variable	Mean (SD) or Median (range)
Age (years)	29.0 (4.9)
Height (cm)	165.6 (8.0)
Weight (Kg)	76.8 (12.7)

Fundal height (cm)	36.0 (3.9)
Parity	1 (1-4)
Gestation (weeks)	32.2 (3.2)

The median FreBAQ score for the eight pain-free women was 1 (IQR 0-1.5, range 0-3) and the median score for the 34 LPP participants was 3.5 (IQR 2-8, range 0-25). This difference was statistically significant (p=0.005). The frequency of responses to each item of the FreBAQ for LPP participants can be found in Table 2. The most frequently endorsed item was item-9, *my back feels lopsided (asymmetrical)*, which was endorsed to some extent by 61.8% of participants. In contrast, only 11.8% of participants endorsed item-8, *my back feels like it has shrunk*.

TABLE 2. Frequency of responses to each item of the FreBAQ in the LPP sample (n=34)

Never %	Rarely %	Occasionally %	Often %	Always %	Median	Mean
1. My back feels as though it is not part of the rest of my body						
76.5	5.9	11.8	5.9	0	0	0.5

2. I need to focus all my attention on my back to make it move the way I want it to						
50	29.4	14.7	5.9	0	0.5	0.8
3. I feel as if my back sometimes moves involuntarily, without my control						
85.3	8.8	2.9	2.9	0	0	.2
4. When performing everyday tasks, I **don't** know how much my back is moving						
64.7	8.8	17.6	8.8	0	0	.7
5. When performing everyday tasks, I am **not** sure exactly what position my back is in						
50	20.6	20.6	5.9	2.9	.5	.9
6. I can't perceive the exact outline of my back						
55.9	14.7	20.6	8.8	0	0	.8

7. My back feels like it is enlarged (swollen)						
64.7	11.8	14.7	5.9	2.9	0	.7
8. My back feels like it has shrunk						
88.2	5.9	5.9	0	0	0	.2
9. My back feels lopsided (asymmetrical)						
38.2	35.3	14.7	8.8	2.9	1	1.0

The clinical status of the 34 participants who reported LPP can be found in Table 3. Untransformed scores are presented for ease of interpretation. The baseline FreBAQ scores were significantly correlated with pain intensity (r=0.378, p=0.027) but not with self-reported disability (r=0.256, p=0.143). These data suggest that greater levels of disturbed body-image are associate with greater pain intensity.

The results of the correlation analysis between FreBAQ score and pain related cognitions, body satisfaction, local tissue sensitivity and clinical measures of body-schema can also be found in Table 3. Of the measured variables only pain catastrophisation was significantly associated with disrupted body-image (r= 0.403, p=0.018). A graphical representation of this relationship can be found in Figure 1. These data suggest that greater levels of disturbed body-image are associate with greater pain catastrophisation.

TABLE 3. Clinical characteristics of the LPP sample (n=34) and correlations with body-image. Significant correlations in bold

Variable	Mean (SD) or Median (IQR)	Correlation with FreBAQ (log transformed)	p-value
Body-image (FreBAQ, 0-36)	3.5 (2 – 8)		
Pain intensity (0-10)	3.9 (1.8)	**0.378**	**0.027**
Disability (PGQ, 0-100)	37.0 (21.7)	0.256	0.143
Pain catastrophisation (PCS, 0-52)	4 (2-9)	**0.403**	**0.018**
Kinesiophobia (TSK, 17-68)	35.3 (5.3)	0.282	0.106
Back beliefs (BBQ, 9-45)	33.3 (6.5)	-0.285	0.103

Body satisfaction (BASS, 0-5)	3.31 (0.28)	0.206	0.243
Two point discrimination (cm)	4.5 (1.0)	0.064	0.718
Left right judgement accuracy (% correct - n=33)	88.8 (8.1)	-0.241	0.176
Punctate sensitivity (0-10)	1 (0.5-2)	0.221	0.209
Temporal summation (-10-10 - n =33)	0.8 (1.0)	-0.064	0.722

FreBAQ – Fremantle back awareness questionnaire

PGQ – pelvic girdle questionnaire

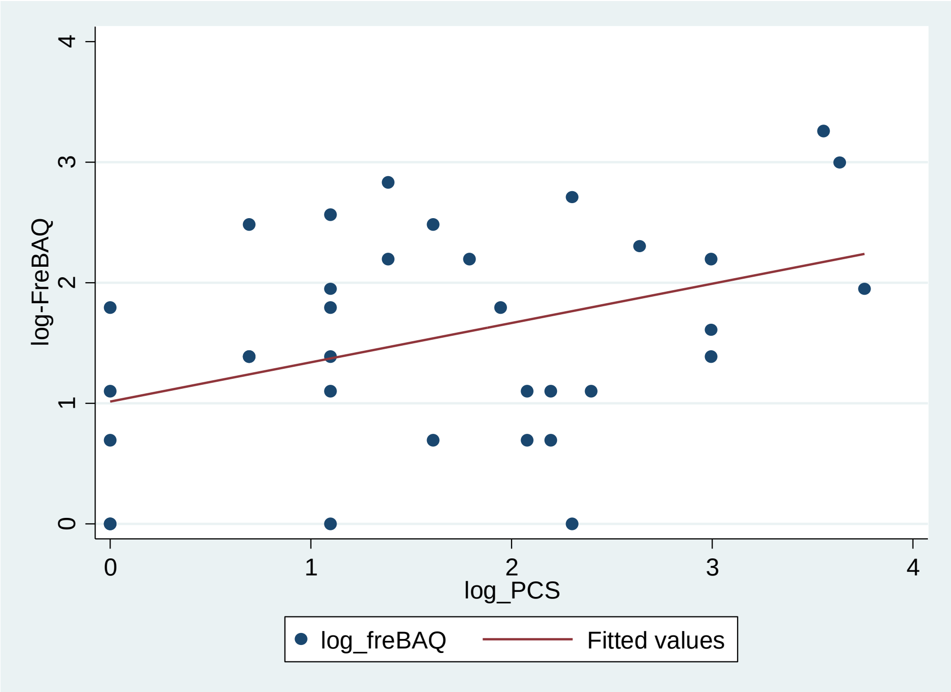
PCS - The Pain Catastrophizing Scale

TSK - Tampa Scale of Kinesiophobia

BBQ – Back beliefs questionnaire

BASS - Body area satisfaction scale

FIGURE 1. Scatter plot illustrating the relationship between self-reported body image and pain catastrophisation**.**



<u>DISCUSSION</u>

The principal aims of this study were to investigate if self-reported changes in body-image were present in women in the third trimester of pregnancy and if these changes were related to clinical severity. We found that the FreBAQ scores of women who were experiencing LPP were significantly higher than those who weren't. Furthermore, amongst those participants who were experiencing LPP, FreBAQ scores were significantly correlated with pain intensity. These data suggest that greater levels of disrupted body-image are associated with greater pain intensity. A number of interventions that potentially target disturbed body-image have been successfully trialled in people with chronic LBP [51-57], and it might be that similar strategies are worth testing in people with pregnancy-related LPP, particularly those who present with evidence of disrupted body-image.

The median value of the FreBAQ reported by the women who were pain free (1) is similar to what we have reported previously in a mixed gender group of healthy controls (0) [41] and a group of women who were pain free post-partum (2) [58]. Direct comparison is difficult due to the small sample size in this study, however the data do suggest that despite the changes in body size and shape during pregnancy, disturbed perceptual awareness of the lumbopelvic region is not present in those who are pain free.

Although FreBAQ scores were significantly higher in those with pain and significantly correlated with pain intensity, the median score reported in this sample (3.5) was somewhat lower than we have found in a small homogeneous sample of people with chronic LBP (11) [41], a large heterogeneous sample of people with chronic LBP (9) [16] and in a sample of women with persistent post-partum LPP (7) [58]. This discrepancy could reflect differences in chronicity and clinical severity. In the present study we excluded people who had experienced any LPP in the six-months prior to the current pregnancy so it is likely that participants had experienced pain for at most a few months. In contrast the people in the chronic LBP samples had experienced pain for around eight to ten years [16, 41] and the post-partum LPP patients about one year [58]. The measures of clinical severity used across the available studies were not identical and not easily compared, however the pain severity recorded in the present sample of around 4/10 is somewhat less that the 5-6/10 seen in the two chronic LBP samples [16, 41]. One speculative interpretation of these data is that altered body-image develops relatively early in an episode of pain and progresses as the condition worsens and persists. Clearly longitudinal data is needed to further understand the potential temporal interactions between altered body-image, clinical severity and pain persistence.

The association between LPP intensity and disturbed body-image is consistent with our previous work in people with chronic LBP [16, 41, 42]. While cross-sectional studies do not provide evidence of causality, it is at least plausible that changes in body-image can impact on the pain experience. Efficient and adaptive movement requires an intact perception of the body and its position in space. Movement quality may be compromised if body-image is disrupted leading to abnormal tissue loading and possible movement related pain [67, 68]. It has also been hypothesised that changes in body representation may give rise to pain due to a mismatch between predicted and actual responses of a motor action [69]. It is also possible that nociceptive sensitivity might be enhanced by changes in body-image. A number of investigators have shown that sensitivity to experimental pain is increased when perception of the body part is distorted by visual manipulation [70-73] and clinical disruption of perceptual awareness might have a similar outcome in patients. We found no association between FreBAQ scores and punctate sensitivity which suggests against this claim, however in previous work we have shown a relationship between pressure pain sensitivity and FreBAQ scores [16]. In that study we found no association with heat or cold pain thresholds [16] and it may be that sensitivity testing such as thermal and punctate measures, which stimulate primarily cutaneous nociceptors, are not responsive to sensitivity changes that may be associated with clinically altered body-image.

A secondary question was to investigate what factors might contribute to altered body-image in pregnancy-related LPP pain. Body-image is a complex issue with varied definitions offered in the literature. What is consistent is that body-image is regarded as a moderately stable, conscious and perceptual construct that is contributed to by multiple factors [74-76]. Most authors agree that body-image emerges from an interaction between internally held body maps, multiple streams of sensory information, motor commands and beliefs and attitudes about the body [43, 76-78].

The testing used here to investigate sensory and motor processes showed no relationship with FreBAQ scores and in fact suggest little disruption in either the postural or representational schema or nociceptive processing. The left/right judgement accuracy rate and TPD distance are very close to what has been previously reported for the healthy pain-free population [47, 79] and the punctate sensitivity scores appear similar to what has been reported in a healthy population using similar methodology [80].

Though previous work has shown an association between fear of movement and FreBAQ scores in chronic LBP [16, 42], we found no association with the TSK or BBQ scores, suggesting that fear of movement and the beliefs about the future consequences of LPP do not impact on altered body-image early in an episode of LPP. However we did find a relationship between body-image and pain catastrophisation, a finding consistent with our previous research in chronic LBP [16, 41, 42], though this should be interpreted cautiously given the generally low levels of catastrophisation in this sample. The pain catastrophisation scale is designed to capture aspects of catastrophic thinking in relation to pain [81] and it is possible that the elements of the questionnaire that may reflect concerns about the integrity of the body in pain underpin this relationship. Interestingly, the BASS demonstrated no relationship with the FreBAQ score, suggesting a dissociation of the more perceptual properties of the body assessed by the FreBAQ and body aesthetics. While speculative, these preliminary results may reflect that early changes in body-image in people in pain are mediated by changes in appraisal of the body with disruption of the sensory and motor correlates developing later. This clearly requires confirmation on larger prospective samples.

The findings of this study need to be interpreted in light of the study limitations. As this was only an exploratory investigation with a limited sample size, the results should be interpreted cautiously as the study may have lacked power to detect some important associations.

Additionally, we did not record or monitor foetal position and it is plausible that this could have impacted on self-reported body-image. In the analysis presented here we have grouped participants with primarily lumbar pain and primarily pelvic pain together, different results might arise in future investigations if these groups are considered separately. Most importantly, the study is cross-sectional so does not provide information on causality, further longitudinal investigations are needed to understand if altered body-image is a cause or a consequence of pain in this population. Finally, other forms of psychophysical testing relevant to body-image such as body form mapping [82], repositioning accuracy [46] or sensory localisation [45] are available and might return different results to the ones presented here.

CONCLUSION

We found that self-reported disruption of body-image was significantly greater in pregnant women who were experiencing LPP than those who weren't and that the extent of body-image disruption was significantly correlated with pain intensity. Further research is needed to determine if there is a causal relationship between disrupted body image and pain in this population. Only pain related catastrophisation was related to disrupted body-image. Tests that investigated sensory and motor function showed no relationship and the values recorded were very similar to those seen in healthy populations. While speculative, these preliminary data suggest that changes in body-image associated with LPP during pregnancy might be primarily driven by negative cognitive factors.

REFERENCES

1. Bastiaanssen JM, de Bie RA, Bastiaenen CHG, Essed GGM, van den Brandt PA: A historical perspective on pregnancy-related low back and/or pelvic girdle pain. *European Journal of Obstetrics & Gynecology & Reproductive Biology* 2005, 120(1):3-14.
2. Gutke A, Östgaard HC, Öberg B: Pelvic girdle pain and lumbar pain in pregnancy: a cohort study of the consequences in terms of health and functioning. *Spine* 2006, 31(5):E149-155.
3. Stomp-van den Berg SG, Hendriksen IJ, Bruinvels DJ, Twisk JW, van Mechelen W, van Poppel MN: Predictors for postpartum pelvic girdle pain in working women: The Mom@Work cohort study. *Pain* 2012, 153(12):2370-2379.
4. Ostgaard HC, Zetherstrom G, Roos-Hansson E: Back pain in relation to pregnancy: a 6-year follow-up. *Spine* 1997, 22(24):2945-2950.
5. Albert H, Godskesen M, Westergaard J: Prognosis in four syndromes of pregnancy-related pelvic pain. *Acta Obstetricia et Gynecologica Scandinavica* 2001, 80(6):505-510.
6. Vleeming A, Albert HB, Ostgaard HC, Sturesson B, Stuge B: European guidelines for the diagnosis and treatment of pelvic girdle pain. *European Spine Journal* 2008, 17(6):794-819.
7. Beales D, O'Sullivan P. A person-centered biopsychosocial approach to assessment and management of pelvic girdle pain. In Jull G, Moore A, Falla D, et al, editors. Grieve's modern musculoskeletal physiotherapy, 4th Edition. London: Elsevier; 2015. p 488-495.

8. Sihvonen T, Huttunen M, Makkonen M, Airaksinen O: Functional changes in back muscle activity correlate with pain intensity and prediction of low back pain during pregnancy. *Archives of Physical Medicine & Rehabilitation* 1998, 79(10):1210-1212.

9. Mogren IM, Pohjanen AI: Low back pain and pelvic pain during pregnancy: prevalence and risk factors. *Spine* 2005, 30(8):983-991.

10. Albert HB, Godskesen M, Korsholm L, Westergaard JG: Risk factors in developing pregnancy-related pelvic girdle pain. *Acta Obstetricia et Gynecologica Scandinavica* 2006, 85(5):539-544.

11. Gutke A, Ostgaard HC, Oberg B: Association between muscle function and low back pain in relation to pregnancy. *Journal Of Rehabilitation Medicine* 2008, 40(4):304-311.

12. Kanakaris NK, Roberts CS, Giannoudis PV: Pregnancy-related pelvic girdle pain: an update. *BMC Medicine* 2011, 9(1):15-29.

13. Aldabe D, Milosavljevic S, Bussey M: Is pregnancy related pelvic girdle pain associated with altered kinematic, kinetic and motor control of the pelvis? A systematic review. *European Spine Journal* 2012, 21(9):1777-1787.

14. Lotze M, Moseley GL: Role of distorted body image in pain. *Current Rheumatology Reports* 2007, 9(6):488-496.

15. Wand BM, Parkitny L, O’Connell NE, Luomajoki H, McAuley JH, Thacker M, Moseley GL: Cortical changes in chronic low back pain: current state of the art and implications for clinical practice. *Manual Therapy* 2011, 16(1):15-20.

16. Wand BM, Catley MJ, Rabey MI, O'Sullivan PB, O'Connell NE, Smith AJ: Disrupted Self-Perception in People With Chronic Low Back Pain. Further Evaluation of the Fremantle Back Awareness Questionnaire. *The Journal Of Pain* 2016, 17(9):1001-1012.

17. Flor H, Braun C, Elbert T, Birbaumer N: Extensive reorganization of primary somatosensory cortex in chronic back pain patients. *Neuroscience Letters* 1997, 224(1):5-8.

18. Lloyd D, Findlay G, Roberts N, Nurmikko T: Differences in Low Back Pain Behavior Are Reflected in the Cerebral Response to Tactile Stimulation of the Lower Back. *Spine* 2008, 33(12):1372-1377.

19. Tsao H, Galea MP, Hodges PW: Reorganization of the motor cortex is associated with postural control deficits in recurrent low back pain. *Brain: A Journal Of Neurology* 2008, 131(8):2161-2171.

20. Tsao H, Daneels L, Hodges PW: Smudging the motor brain in young adults with recurrent low back pain. *Spine* 2011, 36(21): 1721-1727.

21. Schabrun SM, Elgueta-Cancino EL, Hodges PW: Smudging of the Motor Cortex Is Related to the Severity of Low Back Pain. *Spine* 2015, DOI: 10.1097/BRS.0000000000000938.

22. Hotz-Boendermaker S, Marcar VL, Meier ML, Boendermaker B, Humphreys BK: Reorganization in Secondary Somatosensory Cortex in Chronic Low Back Pain Patients. *Spine* 2016, 41(11):E667-E673.

23. Schmidt-Wilcke T, Leinisch E, Ganssbauer S, Draganski B, Bogdahn U, Altmeppen J, May A: Affective components and intensity of pain correlate with structural differences in gray matter in chronic back pain patients. *Pain* 2006, 125(1-2):89-97.

24. Baliki MN, Schnitzer TJ, Bauer WR, Apkarian AV: Brain Morphological Signatures for Chronic Pain. *Plos One* 2011, 6(10):1-13.

25. Ruscheweyh R, Deppe M, Lohmann H, Stehling C, Flöel A, Ringelstein EB, Knecht S: Pain is associated with regional grey matter reduction in the general population. *Pain* 2011, 152(4):904-911.

26. Seminowicz DA, Wideman TH, Naso L, Hatami-Khoroushahi Z, Fallatah S, Ware MA, Jarzem P, Bushnell MC, Shir Y, Ouellet JA *et al*: Effective Treatment of Chronic Low Back Pain in Humans Reverses Abnormal Brain Anatomy and Function. *Journal of Neuroscience* 2011, 31(20):7540-7550.

27. Baliki MN, Petre B, Torbey S, Herrmann KM, Huang L, Schnitzer TJ, Fields HL, Apkarian AV: Corticostriatal functional connectivity predicts transition to chronic back pain. *Nature Neuroscience* 2012, 15(8):1117-1119.

28. Kong J, Spaeth RB, Wey H-Y, Cheetham A, Cook AH, Jensen K, Tan Y, Liu H, Wang D, Loggia ML *et al*: S1 is associated with chronic low back pain: A functional and structural MRI study. *Molecular Pain* 2013, 9.

29. Mao C, Wei L, Zhang Q, Liao X, Yang X, Zhang M: Differences in brain structure in patients with distinct sites of chronic pain: A voxel-based morphometric analysis. *Neural Regeneration Research* 2013, 8(32):2981-2990.

30. Ung H, Brown JE, Johnson KA, Younger J, Hush J, Mackey S: Multivariate classification of structural MRI data detects chronic low back pain. *Cerebral Cortex* 2014, 24(4):1037-1044.

31. Sharma NK, McCarson K, Van Dillen L, Lentz A, Khan T, Cirstea CM: Primary somatosensory cortex in chronic low back pain - a H-MRS study. *Journal Of Pain Research* 2011, 4:143-150.

32. Sharma NK, Brooks WM, Popescu AE, Vandillen L, George SZ, McCarson KE, Gajewski BJ, Gorman P, Cirstea CM: Neurochemical Analysis of Primary Motor Cortex in Chronic Low Back Pain. *Brain Sciences* 2012, 2(3):319-331.

33. Stenberg G, Fjellman-Wiklund A, Ahlgren C: 'I am afraid to make the damage worse' - fear of engaging in physical activity among patients with neck or back pain - a gender perspective. *Scandinavian Journal of Caring Sciences* 2014, 28(1):146-154.

34. Darlow B, Dean S, Perry M, Mathieson F, Baxter GD, Dowell A: Easy to Harm, Hard to Heal: Patient Views About the Back. *Spine* 2015, 40(11):842-850.

35. Bunzli S, Smith A, Watkins R, Schütze R, O'Sullivan P: What Do People Who Score Highly on the Tampa Scale of Kinesiophobia Really Believe?: A Mixed Methods Investigation in People With Chronic Nonspecific Low Back Pain. *The Clinical Journal Of Pain* 2015, 31(7):621-632.

36. Afrell M, Biguet G, Rudebeck CE: Living with a body in pain - between acceptance and denial. *Scandinavian Journal of Caring Sciences* 2007, 21(3):291-296.

37. Osborn M, Smith JA: Living with a body separate from the self. The experience of the body in chronic benign low back pain: an interpretative phenomenological analysis. *Scandinavian Journal of Caring Sciences* 2006, 20(2):216-222.

38. Crowe M, Whitehead L, Gagan MJ, Baxter GD, Pankhurst A, Valledor V: Listening to the body and talking to myself - the impact of chronic lower back pain: a qualitative study. *International Journal of Nursing Studies* 2010, 47(5):586-592.

39. Moseley GL: I can't find it! Distorted body image and tactile dysfunction in patients with chronic back pain. *Pain* 2008, 140(1):239-243.

40. Nishigami T, Mibu A, Osumi M, Son K, Yamamoto S, Kajiwara S, Tanaka K, Matsuya A, Tanabe A: Are tactile acuity and clinical symptoms related to differences in perceived body image in patients with chronic nonspecific lower back pain? *Manual Therapy* 2015, 20(1):63-67.

41. Wand BM, James M, Abbaszadeh S, George PJ, Formby PM, Smith AJ, O'Connell NE: Assessing self-perception in patients with chronic low back pain: development of a back-specific body-perception questionnaire. *Journal Of Back And Musculoskeletal Rehabilitation* 2014, 27(4):463-473.

42. Nishigami T, Mibu A, Tanaka K, Tanabe A, Yamashita Y Shimizu ME, Wand BM, Catley MJ, Stanton TR, Moseley GL: Validation of the Japanese version of The Fremantle Back Awareness Questionnaire in patients with low back pain. *Pain Practice 2017, DOI: 10.1111/papr.12586.*

43. Tsay A, Allen TJ, Proske U, Giummarra MJ: Sensing the body in chronic pain: A review of psychophysical studies implicating altered body representation. *Neuroscience and Biobehavioral Reviews* 2015, 52:221-232.

44. Catley MJ, O'Connell NE, Berryman C, Ayhan Fi, Moseley GL: Is tactile acuity altered in people with chronic pain? a systematic review and meta-analysis. *Journal of Pain* 2014, 15(10):985-1000.

45. Wand BM, Keeves J, Bourgoin C, George PJ, Smith AJ, O'Connell NE, Moseley GL: Mislocalization of sensory information in people with chronic low back pain: a preliminary investigation. *The Clinical Journal Of Pain* 2013, 29(8):737-743.

46. Laird RA, Gilbert J, Kent P, Keating JL: Comparing lumbo-pelvic kinematics in people with and without back pain: a systematic review and meta-analysis. *BMC Musculoskeletal Disorders* 2014, 15(1):229-229.

47. Bray H, Moseley GL: Disrupted working body schema of the trunk in people with back pain. *British Journal of Sports Medicine* 2011, 45(3):168-173.

48. Bowering KJ, Butler DS, Fulton IJ, Moseley GL: Motor imagery in people with a history of back pain, current back pain, both, or neither. *Clinical Journal of Pain* 2014, 30(12):1070-1075.

49. de Lussanet MHE, Behrendt F, Puta C, Weiss T, Lappe M, Schulte TL, Wagner H: A body-part-specific impairment in the visual recognition of actions in chronic pain patients. *Pain* 2012, 153(7):1459-1466.

50. de Lussanet MHE, Behrendt F, Puta C, Schulte TL, Lappe M, Weiss T, Wagner H: Impaired visual perception of hurtful actions in patients with chronic low back pain. *Human Movement Science* 2013, 32(5):938-953.

51. Wand BM, O'Connell NE, Di Pietro F, Bulsara M: Managing Chronic Nonspecific Low Back Pain With a Sensorimotor Retraining Approach: Exploratory Multiple-Baseline Study of 3 Participants. *Physical Therapy* 2011, 91(4):535-546.

52. Morone G, Iosa M, Paolucci T, Fusco A, Alcuri R, Spadini E, Saraceni VM, Paolucci S: Efficacy of perceptive rehabilitation in the treatment of chronic nonspecific low back pain through a new tool: a randomized clinical study. *Clinical Rehabilitation* 2012, 26(4):339-350.

53. Wand BM, Tulloch VM, George PJ, Smith AJ, Goucke R, O'Connell NE, Moseley GL: Seeing it helps: movement-related back pain is reduced by visualization of the back during movement. *The Clinical Journal Of Pain* 2012, 28(7):602-608.

54. Wand BM, Abbaszadeh S, Smith AJ, Catley MJ, Moseley GL: Acupuncture applied as a sensory discrimination training tool decreases movement-related pain in patients with chronic low back pain more than acupuncture alone: a randomised cross-over experiment. *British Journal of Sports Medicine* 2013, 47(17):1085-1089.

55. Trapp W, Weinberger M, Erk S, Fuchs B, Mueller M, Gallhofer B, Hajak G, Kübler A, Lautenbacher S: A brief intervention utilising visual feedback reduces pain and enhances tactile acuity in CLBP patients. *Journal of Back & Musculoskeletal Rehabilitation* 2015, 28(4):651-660.

56. Wälti P, Kool J, Luomajoki H: Short-term effect on pain and function of neurophysiological education and sensorimotor retraining compared to usual physiotherapy in patients with chronic or recurrent non-specific low back pain, a pilot randomized controlled trial. *BMC Musculoskeletal Disorders* 2015, 16(1):1-11.

57. Diers M, Löffler A, Zieglgänsberger W, Trojan J, Löffler A, Zieglgänsberger W: Watching your pain site reduces pain intensity in chronic back pain patients. *European Journal of Pain* 2016, 20(4):581-585.
58. Beales D, Lutz A, Thompson J, Wand BM, O'Sullivan P: Disturbed body perception, reduced sleep, and kinesiophobia in subjects with pregnancy-related persistent lumbopelvic pain and moderate levels of disability: An exploratory study. *Manual Therapy* 2016, 21:69-75.
59. Von Korff M, Jensen MP, Karoly P: Assessing global pain severity by self-report in clinical and health services research. *Spine* 2000, 25(24):3140-3151.
60. Stuge B, Garratt A, Jenssen HK, Grotle M: The Pelvic Girdle Questionnaire: A Condition-Specific Instrument for Assessing Activity Limitations and Symptoms in People With Pelvic Girdle Pain. *Physical Therapy* 2011, 91(7):1096-1108.
61. Sullivan MJL, Bishop SR, Pivik J: The Pain Catastrophizing Scale: Development and validation. *Psychological Assessment* 1995, 7(4):524-532.
62. Vlaeyen JW, Kole-Snijders AM, Boeren RG, van Eek H: Fear of movement/(re)injury in chronic low back pain and its relation to behavioral performance. *Pain* 1995, 62(3):363-372.
63. Symonds TL, Burton AK, Tillotson KM, Main CJ: Do attitudes and beliefs influence work loss due to low back trouble? *Occupational Medicine* 1996, 46(1):25-32.
64. Brown TA, Cash TF, Mikulka PJ: Attitudinal Body-Image Assessment: Factor Analysis of the Body-Self Relations Questionnaire. *Journal of Personality Assessment* 1990, 55(1/2):135.
65. Cash TF: Multidimensional body-self relations questionnaire users manual. N*orfolk: Old Dominion University;* 2000: 1-10.

66. Staud R, Vierck CJ, Cannon RL, Mauderli AP, Price DD: Abnormal sensitization and temporal summation of second pain (wind-up) in patients with fibromyalgia syndrome. *Pain* 2001, 91(1-2):165-175.

67. O'Sullivan P: Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. *Manual Therapy* 2005, 10(4):242-255.

68. Hodges PW, Smeets RJ: Interaction Between Pain, Movement, and Physical Activity: Short-term Benefits, Long-term Consequences, and Targets for Treatment. *Clinical Journal of Pain* 2015, 31(2):97-107.

69. Harris AJ: Cortical origin of pathological pain. *Lancet* 1999, 354(9188):1464-1466.

70. Osumi M, Imai R, Ueta K, Nakano H, Nobusako S, Morioka S: Factors associated with the modulation of pain by visual distortion of body size. *Frontiers in Human Neuroscience* 2014, 8: 137.

71. Osumi M, Imai R, Ueta K, Nobusako S, Morioka S: Negative Body Image Associated with Changes in the Visual Body Appearance Increases Pain Perception. *PLoS ONE* 2014, 9(9):e107376.

72. Martini M, Perez-Marcos D, Sanchez-Vives MV: What Color is My Arm? Changes in Skin Color of an Embodied Virtual Arm Modulates Pain Threshold. *Frontiers In Human Neuroscience* 2013, 7:438-438.

73. Giummarra MJ, Georgiou-Karistianis N, Verdejo-Garcia A, Gibson SJ: Feeling the burn: When it looks like it hurts, and belongs to me, it really does hurt more. *Consciousness & Cognition* 2015, 36:314-326.

74. Giummarra MJ, Gibson SJ, Georgiou-Karistianis N, Bradshaw JL: Mechanisms underlying embodiment, disembodiment and loss of embodiment. *Neuroscience & Biobehavioral Reviews* 2008, 32(1):143-160.

75. de Vignemont F: Body schema and body image—Pros and cons. *Neuropsychologia* 2010, 48(3):669-680.

76. Azañón E, Tamè L, Maravita A, Linkenauger SA, Ferrè ER, Tajadura-Jiménez A, Longo MR: Multimodal Contributions to Body Representation. *Multisensory Research* 2016, 29(6/7):635-661.

77. Longo MR, Azañón E, Haggard P: More than skin deep: Body representation beyond primary somatosensory cortex. *Neuropsychologia* 2010, 48(3):655-668.

78. Longo MR: Implicit and explicit body representations. *European Psychologist* 2015, 20(1):6-15.

79. Wand BM, Catley MJ, Luomajoki HA, O'Sullivan KJ, Di Pietro F, O'Connell NE, Moseley GL: Lumbar tactile acuity is near identical between sides in healthy pain-free participants. *Manual Therapy* 2014, 19(5):504-507.

80. Puta C, Schulz B, Schoeler S, Magerl W, Gabriel B, Gabriel HHW, Miltner WHR, Weiss T: Enhanced sensitivity to punctate painful stimuli in female patients with chronic low back pain. *BMC Neurology* 2012, 12:98-98.

81. Sullivan M: The pain catastrophizing scale: User manual. *Montreal: McGill University* 2009:1-36.

82. Longo MR, Haggard P: An implicit body representation underlying human position sense. *PNAS Proceedings of the National Academy of Sciences of the United States of America* 2010, 107(26):11727-11732.