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ORIGINAL RESEARCH—WOMEN'S SEXUAL HEALTH

Painful Intercourse Is Significantly Associated with Evoked Pain Perception and Cognitive Aspects of Pain in Women with Pelvic Pain

Meryl J. Alappattu, DPT, PhD,*† Steven Z. George, PT, PhD,†‡ Michael E. Robinson, PhD,†§ Roger B. Fillingim, PhD,*¶ Nashat Moawad, MD, MS,** Emily Weber LeBrun, MD, MS,** and Mark D. Bishop, PT, PhD†‡

*Pain Research and Intervention Center of Excellence, University of Florida, Gainesville, FL, USA; †Center for Pain Research and Behavioral Health, University of Florida, Gainesville, FL, USA; ‡Department of Physical Therapy, University of Florida, Gainesville, FL, USA; §Department of Clinical and Health Psychology, University of Florida, Gainesville, FL, USA; ¶Department of Community Dentistry and Behavioral Science, University of Florida, Gainesville, FL, USA; **Department of Obstetrics and Gynecology, University of Florida, Gainesville, FL, USA

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ABSTRACT

Introduction. Evidence suggests that painful intercourse, pain-related psychosocial factors, and altered pain processing magnify the pain experience, but it is not clear how these factors are related to each other.

Aim. The aims were to (i) characterize differences between women with pelvic pain and pain-free women using a battery of pain-related psychosocial measures, clinical pain ratings, and evoked local and remote pain sensitivity; and (ii) examine the relationship between intercourse pain, clinical pain, and local and remote evoked pain sensitivity.

Methods. Women with pelvic pain lasting at least 3 months and pain-free women completed questionnaires and underwent pain sensitivity testing. Self-report measures included clinical pain intensity, pain catastrophizing, pain-related fear, pain anxiety, depression, sexual function, and self-efficacy. Pain sensitivity measures included threshold and tolerance and temporal summation of pain. Separate analyses of variance (ANOVA) were used to test group differences in self-report and pain sensitivity measures. Correlations were calculated among dyspareunia, psychosocial factors, and evoked pain.

Main Outcome Measures. Self-reported pain and pain sensitivity measures.

Results. Twenty-eight pain-free women and 14 women with pelvic pain participated in this study. Women with pelvic pain reported greater pain intensity and greater psychosocial involvement compared with pain-free women. No differences existed between groups for thermal or pressure measures, but women with pelvic pain rated their pain with pain testing significantly higher than pain-free women. Intercourse pain was significantly associated with affective and sensory pain and pressure pain ratings at the puborectalis, vulvar vestibule, adductor longus tendons, and tibialis anterior muscle.

Conclusions. Differences in local pain ratings suggest that women with pelvic pain perceive stimuli in this region as more painful than pain-free women although the magnitude of stimuli does not differ. **Alappattu MJ, George SZ, Robinson ME, Fillingim RB, Moawad N, LeBrun EW, and Bishop MD. Painful intercourse is significantly associated with evoked pain perception and cognitive aspects of pain in women with pelvic pain. Sex Med 2015;3:14–23.**

Key Words. Chronic Pelvic Pain; Dyspareunia; Quantitative Sensory Testing

Introduction

Despite differences in the etiologies of different pelvic pain medical diagnoses (i.e., endometriosis, vulvodynia, painful bladder syndrome, and pelvic inflammatory disease, for example), the overlap of clinical elements of women with chronic pelvic pain (CPP) makes it appropriate to group these patients under the umbrella diagnosis of "chronic pelvic pain." These clinical elements include pain with intercourse (dyspareunia) [1–4], pain during menstruation (dysmenorrhea) [5,6], and reports of myofascial pain of the pelvic floor muscles and proximal soft tissue [2,7–9]. CPP is further described as nonmalignant, continuous or recurrent pain of structures related to the pelvis, lasting at least 6 months, and is often associated with negative sexual, cognitive, and emotional consequences [10]. This condition is also associated with dysfunction in one or usually more of the following body systems: gynecological, urological, gastrointestinal, neurological, and musculoskeletal [11]. The community prevalence of CPP is estimated at nearly 15% [12], and primary care prevalence estimates are comparable with that of low back pain and asthma [13]. The annual economic costs associated with only one type of CPP, endometriosis, have been estimated at nearly $22 billion [14]. This prevalent, costly condition is described as a "medical nightmare" for clinicians [11]. Women with CPP report depression, anxiety, and sleep disturbances, in addition to limitations in sexual activity and mobility [15,16].

Women with CPP also exhibit evidence of pain-related psychological involvement, including catastrophizing, fear, and hypervigilance during intercourse. Payne et al. reported that women with vulvodynia reported more hypervigilance to pain during intercourse, suggesting that increased attention paid to a threat of potentially painful stimuli during intercourse may interfere with sexual arousal and diminish the experience of intercourse [17]. Women with vulvodynia also report more catastrophizing thoughts related to intercourse pain compared with nonintercourse pain [18]. In a survey of women with interstitial cystitis (IC) [19], a significant number of them with pelvic pain complaints reported fear of pain with intercourse compared with healthy controls, in addition to significantly higher reports of dyspareunia. Collectively, these studies suggest that despite differences in reported etiologies, women with CPP suffer from painful intercourse and are potentially influenced by pain-related psychological factors that likely exacerbate this pain experience.

In addition to clinical symptoms such as pain and psychological distress, women with CPP exhibit increased sensitivity to local and remote noxious stimuli compared with healthy women [8,18,20–22]. Granot et al. applied a series of thermal stimuli to the forearms of women with vulvodynia and also to healthy women and reported that heat pain thresholds of women with vulvodynia were significantly lower than those of healthy women [21]. Additionally, suprathreshold pain ratings and anxiety scores were significantly higher for the women with vulvodynia. These results suggest that women with vulvodynia may have enhanced pain sensitivity, perhaps due in part to changes in central nervous system-mediated pain processing. Alterations in central nervous system processing are believed to contribute to the maintenance of pain in pelvic pain conditions such as vulvodynia [21,22], irritable bowel syndrome [23], and endometriosis [24] and other chronic pain conditions including fibromyalgia [25,26] and low back pain [27,28].

Aims

The available literature suggest that reports of pain and painful intercourse, pain-related psychosocial factors, and enhanced pain sensitivity magnify the pain experience, but it is not clear how these factors are related to each other. In particular, the relationship between intercourse pain, local and remote pain sensitivity, and positive and negative pain-related psychosocial factors is unclear. Understanding the relationship between the presence of pain-related psychological factors and painful intercourse may guide clinical decision-making when determining which interventions to use. The aim of this report was to characterize differences between women with CPP and women without pain using a comprehensive battery of pain-related psychosocial measures, nonevoked clinical pain ratings, and evoked local and remote pain sensitivity. The second aim was to examine the relationship between intercourse pain, nonevoked pain ratings, and local and remote evoked pain sensitivity. We hypothesized that women with CPP would exhibit significantly higher local and remote evoked pain sensitivity, higher levels of depression, clinical pain intensity, sexual dysfunction, pain with intercourse, pain-related psychological involvement (including

pain catastrophizing, pain-related fear, and pain anxiety), and significantly lower levels of pain self-efficacy compared with pain-free women. Last, we hypothesized that intercourse pain in women with CPP would be significantly positively associated with local evoked pain sensitivity and ratings, pain catastrophizing, pain-related fear, and pain anxiety.

Methods

Participants were recruited via electronic and flyer advertisements on the University of Florida campus and University of Florida Health outpatient medical and rehabilitation clinics. All participants completed a single session where they completed pain self-report and pain-related psychosocial measures and underwent pain sensitivity testing. All participants completed this testing session between days 4 and 20 of their menstrual cycle. All participants were instructed to abstain from taking any pain medications (oral or topical) within 24 hours of the testing session. The University of Florida Institutional Review Board approved this study, and all participants signed an Informed Consent Form prior to participation in this study. Seventy-three pain-free individuals responded to the advertisements. Of these, two were excluded for being male, seven did not meet the eligibility criteria, 16 were screened and eligible to participate but did not complete the first session, and 20 responded to the study after pain-free recruitment was completed. Twenty women with CPP responded to the advertisements. Of these, four did not meet the eligibility criteria, and two were screened and eligible to participate but did complete the first session.

Inclusion and Exclusion Criteria

Both pain-free women and women with pelvic pain lasting 3 months or longer were included in this study. Though the EAU Guidelines for Chronic Pelvic Pain define CPP as lasting 6 months or longer [10], other groups, including the National Institutes of Health [29] and the Institute of Medicine [30], describe chronic pain as lasting 3 months or longer. We chose the more liberal of these timeframes for this study. The inclusion criteria for the pain-free women included age 18 or older and no complaints of pelvic pain. The inclusion criteria for women with pelvic pain included age 18 or older and primary pelvic pain complaint associated with one or more of the following diagnoses confirmed by their physician: CPP, painful bladder syndrome/IC, vulvodynia, endometriosis, dyspareunia, dysmenorrhea, coccygodynia, irritable bowel syndrome, pelvic inflammatory disease, prior pelvic surgery, and myofascial pain. Exclusion criteria included sensory loss of the hands or feet, pregnancy, never having undergone a gynecological pelvic examination, and/or currently undergoing physical therapy for pelvic pain.

Main Outcome Measures

Pain Sensitivity

Quantitative Sensory Testing measures included both thermal and pressure stimuli, and participants rated their pain using the 101-point Numerical Pain Rating Scale (NPRS). Both thermal and pressure stimuli were used to assess each participant's threshold and/or tolerance to pain. Pain sensitivity testing consisted of two practice intervals of both thermal and pressure stimuli followed by a baseline interval with recorded data. Pain sensitivity measures included thermal threshold and tolerance, pressure threshold, and temporal sensory summation of pain. All thermal stimuli were delivered with a thermode controlled by the Medoc Neurosensory Analyzer (TSA-2001; Medoc Inc., Ramat Yishai, Israel). The delivered temperatures ranged from 35 to 51°C.

To assess thermal threshold and tolerance, a continuous heat stimulus was delivered to the participants' dominant forearm. The stimulus began at 35°C and was increased at a rate of 0.5°C with subjects terminating the stimulus when the temperature reached pain threshold ("when the sensation of heat first changed from heat to pain") and tolerance (when the heat sensation became so strong the participant could no longer stand to have the thermode on their skin). Threshold and tolerance were measured twice at each testing interval, and the average threshold and tolerance were calculated. Additionally, thermal stimuli were used to evaluate temporal summation of pain (TSP). TSP is a dynamic measure of pain processing thought to capture the pain modulation ability of the central nervous system. To assess TSP, a train of six heat pulses was applied to the glabrous skin of participants' dominant foot. An interstimulus interval of 2.5 seconds was used, and the temperature of each heat pulse fluctuated from a baseline of 35°C to 48°C during each stimulus. The participants were asked to rate the magnitude of their delayed (second) pain sensation following each pulse. This procedure was performed once on the dominant

foot. These response ratings are believed to be primarily C-fiber mediated.

Pressure pain threshold (PPT) was assessed at the bilateral internal puborectalis muscles and upper and lower vulvar vestibule with the use of a thimble algometer using techniques described by Zolnoun and colleagues [31]. A handheld algometer was used to assess PPT at the bilateral adductor longus tendons, dominant tibialis anterior, and dominant thumb web.

Self-Report Measures

NPRS

The 101-point NPRS evaluates pain intensity using a scale whose end points are designated as "0 = no pain sensation" and "100 = the most intense pain sensation imaginable." Numerical rating scales are a valid and reliable clinical measure to assess pain intensity [32,33]. The NPRS was used to assess current, least, worst, and resting pelvic pain and intercourse pain in the last 48 hours and last 7 days.

Short-Form McGill Pain Questionnaire

The Short-Form McGill Pain Questionnaire is a 20-item index that measures pain in the affective, sensory, and evaluative domains. This valid and reliable [34,35] measure evaluated the quality of the participants' pelvic pain.

Female Sexual Function Index

The Female Sexual Function Index (FSFI) is a 19-item questionnaire that measures sexual functioning in women in six domains: desire, arousal, lubrication, orgasm, satisfaction, and pain. Total scores range from 2 to 36 with scores less than 26 indicative of sexual dysfunction. The FSFI has demonstrated high internal consistency (Cronbach's alpha 0.91–0.97) and good test–retest reliability ($r = 0.79$–0.90) in women with CPP [36–38].

Pain Anxiety Symptoms Scale

The Pain Anxiety Symptoms Scale (PASS) is a 20-item self-report measure that evaluates pain-related fear and anxiety in persons with chronic pain disorders. The PASS-20 has high internal consistency (Cronbach's alpha 0.91) and a stable factorial structure [39,40].

Pain Catastrophizing Scale

The Pain Catastrophizing Scale (PCS) is a 13-item scale that measures pain catastrophizing in clinical and nonclinical populations under three domains: rumination, magnification, and helplessness. The PCS is a reliable and valid measure (Cronbach's alpha 0.92) with a stable factorial structure [41,42].

Patient Health Questionnaire

The Patient Health Questionnaire-9 is a nine-item self-report measure that evaluates the presence of depressive symptoms. This measure is valid and sensitive and specific to depressive symptoms [43].

Tampa Scale for Kinesiophobia (TSK-11)

The TSK-11 is an 11-item self-report measure that assesses elevated pain-related fear beliefs related to movement or activity. This measure has good internal consistency (Cronbach's alpha = 0.79) and test–retest reliability (intraclass correlation coefficient = 0.81) [44].

Pain Self-Efficacy Questionnaire (PSEQ)

The PSEQ is a 10-item self-report measure that assesses one's ability to perform a variety of activities, including work, household duties, and social activities, despite of pain. The PSEQ has a high internal consistency (Cronbach's alpha = 0.92) and good test–retest reliability ($r = 0.73$) [45].

Statistical Analyses

Statistical analyses were conducted using IBM SPSS STATISTICS Version 20 (IBM Corporation, Armonk, NY, USA). Alpha was set at the 0.05 level for all analyses. Separate analyses of variance (ANOVA) were used to test differences between groups on pain sensitivity measures and self-report measures. Bivariate correlations were calculated among intercourse pain, pain-related psychosocial factors, and evoked pain ratings using Pearson correlation moments.

Sample Size Estimates

Using previously published effect size estimates for cutaneous pain (effect size = 0.49) from a similar study protocol in patients with irritable bowel syndrome [46], alpha of 0.05 and power of 80%, the required sample size to predict differences in cutaneous pain ranged was 22. To account for potential dropouts, we planned to enroll an additional 25% of participants and sought 28 participants per group.

Results

Demographic Factors

The average age of the pain-free group (N = 28) was 29.5 years, and the average age of the CPP

Table 1 Demographic information and medical diagnoses of pelvic pain participants

Participant	Medical diagnosis (or diagnoses)	Race
1	CPP, dysmenorrhea, endometriosis, myofascial pain	White
2	CPP, dysmenorrhea, endometriosis	White
3	CPP	Black
4	CPP, dyspareunia, endometriosis	White
5	CPP, myofascial pain	Black
6	CPP, myofascial pain	White
7	CPP, dysmenorrhea, myofascial pain	American Indian
8	CPP, dyspareunia, IBS, myofascial pain	White
9	Dyspareunia	Black
10	Painful bladder syndrome	White
11	CPP, dysmenorrhea, dyspareunia	White
12	CPP, dysmenorrhea, endometriosis, myofascial pain	White
13	CPP, dysmenorrhea, endometriosis	White
14	Dyspareunia, myofascial pain, painful bladder syndrome	White

CPP = chronic pelvic pain; IBS = irritable bowel syndrome

group (N = 14) was 39.57 years ($P = 0.02$). The average duration of pelvic pain was 60.35 months for the CPP group. The medical diagnoses and races of the pelvic pain group are listed in Table 1.

Pain Intensity and Quality

As expected, women with CPP reported significantly higher current, resting, and intercourse pain during the last 48 hours and 7 days. The worst and least pelvic pain reported by the CPP group during the last 2 and 7 days was also significantly higher than the pain-free group (see Table 2). The CPP group reported significantly higher scores on both the sensory and affective domains of the McGill Pain Questionnaire (see Table 2).

Pain-Related Psychosocial Factors

Age was significantly positively correlated with measures of depression, self-efficacy, and sexual function and included in the comparisons as a covariate using analyses of covariance (ANCOVA) for these measures. Women with CPP demonstrated significantly higher pain anxiety, depression, catastrophizing, and pain-related fear compared with pain-free women, as well as lower pain self-efficacy. The CPP group also scored significantly lower on the FSFI, with the average score for the group on this measure indicative of sexual dysfunction (see Table 3).

Pain Sensitivity

Age was not significantly correlated with any of the measures of pain sensitivity and therefore not included in any of the comparisons. Women with CPP demonstrated no significant differences in PPT at any local or remote sites compared with pain-free women. However, women with CPP rated their pain significantly higher than pain-free women at the left puborectalis muscle and the upper vestibule ($P = 0.03$ and 0.02, respectively; see Table 4), indicating that their perception of pain at these sites was higher. No differences existed between groups for any of the thermal measures but did approach significance for TSSP (see Table 5).

Correlations Between Intercourse Pain with Psychosocial Factors and Pain Sensitivity in Women with CPP

Intercourse pain intensity was significantly positively correlated with both the affective and sensory domains of the McGill Pain Questionnaire (MPQ). Intercourse pain was also signifi-

Table 2 Pain sensitivity and quality

	Pain free (SD)	Pelvic pain (SD)	*P* value
Current pain	0.00 (0.00)	27.51 (24.58)	<0.001*
Current pain at rest	0.00 (0.00)	20.00 (22.19)	<0.001*
Least pain 48 hours	0.00 (0.00)	15.28 (15.65)	<0.001*
Least pain 7 days	0.11 (0.57)	20.36 (28.09)	<0.001*
Least pain at rest 48 hours	0.00 (0.00)	12.50 (14.88)	<0.001*
Least pain at rest 7 days	0.36 (0.36)	9.64 (11.97)	<0.001*
Worst pain 48 hours	0.00 (0.00)	46.57 (27.26)	<0.001*
Worst pain 7 days	1.96 (4.58)	55.50 (32.90)	<0.001*
Worst pain at rest 48 hours	0.18 (0.94)	28.29 (22.46)	<0.001*
Worst pain at rest 7 days	1.43 (4.35)	45.79 (33.15)	<0.001*
Intercourse pain 48 hours	0.82 (2.25)	39.86 (36.91)	<0.001*
Intercourse pain 7 days	1.07 (2.52)	39.93 (36.83)	<0.001*
MPQ-S	1.57 (2.10)	16.25 (4.58)	<0.001*
MPQ-A	0.21 (0.63)	3.64 (3.23)	<0.001*

*Indicates significance at 0.05 level
Values are mean (SD)
MPQ = McGill Pain Questionnaire; S = sensory subscale; A = affective subscale; SD = standard deviation

Table 3 Pain-related psychosocial distress and sexual function

	Pain free (SD)	Pelvic pain (SD)	*P* value
PASS	23.43 (17.97)	43.36 (19.58)	0.002*
PHQ†	1.82 (1.74)	8.21 (5.00)	<0.001*
PSEQ†	51.92 (12.26)	40.77 (10.92)	0.006*
PCS	9.21 (9.66)	23.14 (12.40)	<0.001*
FSFI†	27.69 (4.95)	21.16 (6.73)	0.001*
TSK-11	15.79 (4.10)	23.14 (4.45)	<0.001*

*Indicates significance at the 0.05 level
†After controlling for age. Age fixed at 32.9 in each covariate model
FSFI = Female Sexual Function Index; PASS = Pain Anxiety Symptoms Scale; PCS = Pain Catastrophizing Scale; PHQ = Patient Health Questionnaire; PSEQ = Pain Self-Efficacy Questionnaire; SD = standard deviation; TSK-11 = Tampa Scale of Kinesiophobia

cantly correlated with pressure pain ratings at the right puborectalis muscle, lower vestibule, adductor longus, and tibialis anterior but not with any other evoked pressure pain ratings (see Table 6).

Interim Analysis of Effect Sizes

A post hoc decision was made to perform an interim analysis to calculate effect sizes for local and remote pain sensitivity measures. In order to detect group differences in pain sensitivity given the calculated effect sizes, we would have been required to enroll 140 participants to detect remote site differences and 548 participants to detect local site differences. Therefore, we decided to end the current study with enrollment of 28 healthy participants and 14 participants with pelvic pain.

Discussion

The first aim of the current study was to compare psychosocial factors and local and remote pain sensitivity in women with and without pelvic pain. The second aim was to examine the relationships between intercourse pain, local and remote evoked pain intensity, and nonevoked subjective pain intensity. The results of the first aim of this study demonstrated that women with pelvic pain reported greater pain intensity and greater pain-related psychosocial involvement compared with healthy women. The CPP group reported significantly higher least, worst, current, intercourse, and resting pelvic pain compared with women without pain in a 48-hour and 7-day period. Perhaps the most surprising of these subjective pain ratings was the higher resting pain. Increased nociceptive input associated with activation of the pelvic floor muscles during movement or with noxious pressure to the mucosa overlying these muscles (i.e., during intercourse) is conceivable in women with pelvic pain. Higher subjective pain while completely at rest may indicate that nociceptive input from the pelvic region is ongoing in women with pelvic pain and is not always associated with movement or external noxious stimuli in that region.

Interestingly, the results of the current study do not fully support our original hypothesis or previous research [21,22,24,31] that women with pelvic pain would be more sensitive to heat and pressure stimuli compared with healthy women; that is, we expected women with CPP would have lower thresholds for heat and pressure stimuli. However, no differences existed between groups for the thermal measures or any of the local or remote pressure measures. Though the amount of force required to reach pressure threshold was consistently lower for women with CPP compared with

Table 4 Local and remote PPT (in Newtons) and pain ratings (0–100 NPRS)

	Pain free (SD)	Pelvic pain (SD)	*P* value	Effect size (*r*)
Right puborectalis PPT	11.05 (7.37)	9.26 (6.06)	0.45	0.12
Right puborectalis rating	18.57 (18.73)	27.36 (23.53)	0.21	0.20
Left puborectalis PPT	9.06 (8.19)	5.55 (5.39)	0.16	0.22
Left puborectalis rating	17.65 (19.07)	34.96 (26.28)	0.02*	0.36
Upper vestibule PPT	17.70 (8.71)	13.49 (6.09)	0.11	0.25
Upper vestibule rating	11.71 (15.09)	25.35 (25.21)	0.03*	0.33
Lower vestibule PPT	11.70 (7.83)	9.59 (6.60)	0.39	0.14
Lower vestibule rating	17.88 (18.48)	28.25 (26.11)	0.14	0.23
Adductor longus PPT	23.31 (8.74)	19.42 (5.66)	0.14	0.23
Adductor longus rating	17.39 (17.71)	23.75 (21.07)	0.31	0.16
Tibialis anterior PPT	61.03 (18.72)	53.75 (14.77)	0.21	0.20
Tibialis anterior rating	16.43 (3.09)	23.71 (16.36)	0.22	0.19
Thumb web PPT	35.89 (15.54)	28.96 (8.27)	0.13	0.24
Thumb web rating	16.13 (17.54)	22.79 (19.74)	0.27	0.17

*Indicates significance at 0.05 level
Values are mean (standard deviation)
NPRS = Numerical Pain Rating Scale; PPT = Pressure pain threshold; SD = standard deviation

Table 5 Thermal pain threshold and tolerance and pain ratings

	Pain free (SD)	Pelvic pain (SD)	*P* value	Effect size (*r*)
HTh (°C)	43.20 (2.80)	44.19 (2.16)	0.25	0.18
HTh rating	18.23 (21.36)	30.36 (25.82)	0.11	0.25
HTol (°C)	47.81 (1.64)	47.06 (1.18)	0.13	0.23
HTol rating	50.34 (30.29)	49.43 (29.21)	0.93	0.01
TS magnitude	3 (13.80)	9.36 (10.07)	0.05*	0.23

*Indicates significance at 0.05 level
Values are mean (standard deviation)
HTh = heat threshold; HTol = heat tolerance; SD = standard deviation; TS = temporal summation

pain-free women, these differences did not reach statistical significance. Our study did not include a design specifically to test sensitivity using standardized stimuli, for example, apply the same pressure to the pelvic floor and vestibule of all participants and ask them to rate that pressure. Because of this, we are unable to make comments regarding hyperalgesia. However, there is some evidence to suggest that women with CPP were more sensitive to locally applied stimuli. The differences that did exist between groups were the pain *ratings* at the pelvic floor and vestibule, suggesting that the *perception* of stimuli applied in the pelvic region was greater for women with CPP even though the magnitude of the stimuli did not differ. Another potential contributing factor was the heterogeneity of the pelvic pain group. Though the majority of the group was diagnosed with CPP, medical conditions with different etiologies (e.g., painful bladder syndrome or endometriosis) may also exhibit differences in local and remote pain modulation. Though our study was not powered to detect these differences in the pelvic pain sample, future studies should consider examining pain modulatory differences in women with different medical conditions associated with pelvic pain.

In addition to subjective pain reports and consistent with previous research [17,22,47,48], women with pelvic pain also exhibited greater pain-related psychosocial involvement with elevated scores in measures of negative affect. The CPP group also reported a decreased pain self-efficacy, which is the ability to effectively function in everyday activities despite the presence of pain. The presence of pain-related psychosocial factors such as anxiety, pain-related fear, and catastrophizing, for example, are well-established in women with pelvic pain. The finding of reduced pain self-efficacy adds to the previous body of work by suggesting that a woman with CPP has less belief in her in ability to affect or control pain and the impact of

Table 6 Associations between intercourse pain, evoked local and remote pain ratings, and pain-related psychosocial factors in women with CPP

	MPQ-S	MPQ-A	FSFI	PASS	PSEQ	PCS	TSK-11	PHQ	Right puborectalis	Left puborectalis	Upper vestibule	Lower vestibule	Adductor longus	Tibialis anterior	Thumb web	Heat threshold	Heat tolerance
Intercourse pain	0.60*	0.67*	−0.46	0.25	0.34	0.13	−0.69	0.16	0.62*	0.42	0.55*	0.60*	0.58*	0.54	0.52	0.40	0.36
MPQ-S		0.66*	−0.33	0.23	0.11	0.18	0.17	0.27	0.46	0.42	0.31	0.39	0.44	0.41	0.42	0.40	0.36
MPQ-A			−0.36*	0.25	0.31	0.38	−0.19	0.12	0.32	0.17	0.15	0.22	0.28	0.17	0.15	0.10	0.22
FSFI				−0.27	−0.04	−0.23	−0.56*	−0.32	−0.57*	−0.35	−0.53	−0.61*	−0.62*	−0.67*	−0.50	−0.30	−0.32
PASS					−0.14	0.69*	0.34	−0.38	0.10	0.01	0.03	0.04	0.07	0.14	0.14	0.12	−0.15
PSEQ						−0.21	−0.32	−0.02	0.44	0.58*	0.49	0.46	0.40	0.37	0.42	0.48	0.61*
PCS							0.38	−0.48	−0.09	−0.20	−0.22	−0.17	−0.12	−0.17	−0.26	−0.20	−0.24
TSK-11								0.01	0.06	0.11	0.02	0.13	0.11	0.20	0.04	−0.04	−0.07
PHQ									0.21	0.26	0.18	0.36	0.22	0.33	0.33	0.09	0.37
Right puborectalis										0.88*	0.95*	0.94*	0.99*	0.95*	0.92*	0.85*	0.80*
Left puborectalis											0.83*	0.85*	0.83*	0.83*	0.84*	0.85*	0.90*
Upper vestibule												0.96*	0.96*	0.96*	0.95*	0.86*	0.76*
Lower vestibule													0.95*	0.97*	0.92*	0.78*	0.76*
Adductor longus														0.96*	0.92*	0.82*	0.76*
Tibialis anterior															0.96*	0.81*	0.73*
Thumb web																0.90*	0.79*
Heat threshold																	0.85*

*Indicates significance at the 0.05 level
FSFI = Female Sexual Function Index; MPQ = McGill Pain Questionnaire; S = sensory subscale; A = affective subscale; PASS = Pain Anxiety Symptoms Scale; PCS = Pain Catastrophizing Scale; PHQ = Patient Health Questionnaire; PSEQ = Pain Self-Efficacy Questionnaire; TSK-11 = Tampa Scale of Kinesiophobia

that pain on her function. Thus, the coping abilities of women with pelvic pain may also contribute to their pain experience.

The relationship of these psychosocial factors to clinical symptoms of pelvic pain and potential impact on sexual activity, including pain with intercourse and sexual dysfunction, is less clear. We originally hypothesized significant positive associations between pain sensitivity, psychosocial factors, and painful intercourse, and our results partially support this hypothesis. Intercourse pain was significantly associated with MPQ affective and sensory subscales and PPT ratings at the puborectalis, vulvar vestibule, adductor longus tendons, and tibialis anterior muscle. The association between intercourse pain and both local and remote sites suggests altered central pain processing. Thus, asking a woman with pelvic pain if she has pain with intercourse is a potential indicator of enhanced supraspinal involvement in nociceptive processing and may provide direction for centrally acting vs. peripheral treatment. While we do not believe our findings to be robust enough to suggest central vs. peripheral pharmacological interventions, we do agree that the combination of findings would represent a woman with more centrally mediated pain. Intercourse pain was not associated with any other pain-related psychosocial factors or pain sensitivity measures. A potential reason for this lack of an association between intercourse pain and pain-related psychosocial measures may be that the measures were not dyspareunia specific but asked about pain in general.

Others have reported a lack of a relationship between intercourse pain and pain sensitivity measures. One potential reason for this lack of a relationship may be the nature of the stimulus used to experimentally evoke pain. A recent study by Desrochers et al. [49] examined the relationship of catastrophizing, hypervigilance, anxiety, pain self-efficacy, and pain-related fear with intercourse compared with evoked pain of the vulvar vestibule. Their results suggested that little correlation existed between palpation of the vulvar vestibule and the aforementioned psychosocial variables, to which the authors contributed to the relatively nonemotional experience of experimentally induced pain vs. the highly emotional experience of intercourse. A potential reason for the association between intercourse pain and local evoked pain shown in our current study compared with the aforementioned study may be the type of stimulus used to assess local pain sensitivity. Digital assessment with a thimble algometer used in the current study may have more closely mirrored sexual activity compared with a cotton swab applied at the vestibule. Though matching the emotional experience of intercourse may not be ideal in an experimental setting, future studies should consider using stimuli that better represent painful sexual stimuli.

Limitations

Several limitations exist in the current study. A significant limitation is the heterogeneity in medical diagnoses of the sample of participants with pelvic pain. Potential differences in the etiologies of this group may have contributed to the variability of pain sensitivity at local and remote sites. Future studies should consider a more homogenous sample of patients with pelvic pain. Second, there was large variability of thresholds and ratings in both pain-free women and women with CPP. This variability is not unexpected given known individual differences in the pain experience but does increase sample size requirements. This study may have been underpowered to detect group differences, especially given the smaller sample size of the pelvic pain group. A second contributing factor to the high variability may have been the number of practice sessions. Though all participants practiced rating their pain with the thermal and pressure stimuli prior to the baseline and testing intervals, the practice intervals occurred within the same session. Practicing the testing procedures over the several days or sessions may have helped to reduce this variability by better preparing participating how to use the rating systems and accustom them further to the range of temperatures and pressures that they might experience during testing.

Another limitation is that the CPP sample in this study included women with a variety of different pelvic pain diagnoses that may or may not have included pain of the pelvic floor or vestibule, which is where the local pressure stimuli were applied. More focused diagnostic criteria and physical screening of participants' pelvic floor musculature might be important for future studies examining pelvic floor muscle sensitivity in response to an intervention. Last, though we instructed women to refrain from taking oral pain medications or apply any topical analgesics within 24 hours of the testing session, we did not ask them to refrain from other medications, such as tricyclic antidepressants, which are used to treat chronic pain.

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Corresponding Author: Meryl J. Alappattu, DPT, PhD, Pain Research and Intervention Center of Excellence, University of Florida, PO Box 100444, Gainesville, FL 32610, USA. Tel: 352-273-6147; Fax: 352-392-3031; E-mail: meryl@ufl.edu

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