DEPRESSIVE SYMPTOMS, LONELINESS, AND OTHER PSYCHOSOCIAL FACTORS IN WOMEN WITH PAIN-RELATED SEXUAL DYSFUNCTION

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Indianapolis, IN

2016

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
December, 2020

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ACKNOWLEDGEMENTS

I would like first to express my gratitude to my advisor, Dr. Misty Hawkins, for her continuous guidance and support through this project and beyond. Without her support, I would not have made it through my first year of graduate school, and certainly would not have completed this project. In addition, I would like to thank the rest of my committee, Drs. Lucia Ciciolla and Tony Wells, for their invaluable input and improvements to this document. I also want to thank Dr. Adam Hirsh for allowing me to complete the pilot study for this project as an undergraduate in his lab.

Big thanks to my cohort and lab mates in the REACH Lab. Finally, I want to thank my family and friends. Luke Fisher, I am eternally grateful for our friendship. Thank you for your unwavering support, endless supply of positivity, and absolutely devastating sense of humor.

Name: MADISON ELIZABETH STOUT

Date of Degree: DECEMBER, 2020

Title of Study: DEPRESSIVE SYMPTOMS, LONELINESS, AND OTHER PSYCHOSOCIAL FACTORS IN WOMEN WITH PAIN-RELATED SEXUAL DYSFUNCTION

Major Field: PSYCHOLOGY

Abstract: Women who experience pain during sexual intercourse (PDI) report higher rates of depressive mood symptoms. Loneliness might mediate these relationships. In this longitudinal study, I hypothesized that women who experienced greater PDI (i.e., more severe and interfering pain) would report higher rates of loneliness and, in turn, higher rates of depressive symptoms at a 6-month follow-up. Participants were 230 adults who were assigned female at birth (79.1% white, 63.9% partnered, 34.25 ± 13.7 years old) completed an online, anonymous survey including Female Sexual Function Index (FSFI), Patient Health Questionnaire-8 (PHQ8), UCLA Loneliness Scale-3 (ULS), and demographic information. Bivariate associations and bootstrapped mediation analysis examined the relationships among PDI and ULS at baseline (T1) and change in PHQ8 at 6-months (T2). PDI and ULS at T1 were significantly correlated with each other and with PHQ8 at T1. However, change in PHQ8 from T1 to T2 was not significantly correlated with any key study variables. Results of the mediation analysis indicated that ULS was not a significant mediator of the relationship between PDI at T1 and change in PHQ8 (standardized indirect effect = .011; 99% CI = -.114 to .188). These findings are consistent with previous studies highlighting that pain during intercourse is related to depressive symptoms, cross-sectionally. The lack of a significant prospective association with change in PHQ8 over time could be the result of several study limitations, including the short follow-up period and use of a non-clinical sample.

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CHAPTER I

INTRODUCTION

Overview

Sexual behaviors, including sexual intercourse, can be important components of a romantic relationship, having important implications for mental and physical health. Individuals in relationships who engage in consensual sexual intercourse more frequently are more emotionally and physically satisfied and tend to report higher overall quality of life [1-3]. Being satisfied with one's sex life is also related to improved quality of and satisfaction with romantic relationships, and dissatisfaction with sexual activities is related to dissatisfaction with romantic relationships [4-8], which may contribute to increased depressive symptoms [6]. Thus, women with sexual dysfunction, or difficulties in one or more area of sexual function, tend to report less life and relationship satisfaction and greater psychological distress [9-11], specifically greater depressive symptoms [12-15]. The current project examined one area of sexual dysfunction, genital pain or discomfort during sexual intercourse, as a critical factor that may be prospectively associated with heightened depressive symptoms among adult women, and also examined loneliness as a mediator of this relationship.

Pain during Intercourse (PDI): Statement of the Problem

Definitions and Prevalence. Sexual dysfunction describes significant difficulties with one or more of the following areas: interest in sex, arousal, lubrication, orgasm, satisfaction, and genital comfort; and affects 14 to 53% of women [16-20]. Further, around 40 to 50% of women will endorse at least one symptom of sexual dysfunction in their lifetime [21]. Genital discomfort or PDI is one aspect of sexual dysfunction, affecting between 6.5 and 45% of older women and 14 and 34% of younger women [22-24]. Some evidence suggests that sexual dysfunction is related lower frequency and/or poorer quality of sexual intercourse, which can lead to increased negative mood [25, 26]. However, other studies suggest that PDI and sexual satisfaction might be unrelated [27], meaning that the sex lives of women who experience PDI are might not be impaired by pain, but by other factors, including anxiety and avoidance of sex [27], or perhaps communication with partners.

Clinical Sexual Dysfunction. There are four categories of sexual disorders in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), including disorders on desire, arousal, orgasm, and pain. When a woman's vaginal discomfort during sex reaches severe and psychologically distressing levels, she may meet criteria for a sexual dysfunction disorder. The *DSM-IV-TR* described two female sexual function disorders involving genital pain: Dyspareunia and Vaginismus. Dyspareunia described vulvovaginal pain (i.e. pain in the vagina and/or the surrounding area) caused by penetrative intercourse. Vaginismus described genital tightness caused by muscle spasms which interfered with or impeded penetration during intercourse [28], but pain was often also reported by women with vaginismus [29]. For this reason, the *DSM-5,* revised these

two disorders by merging them into one: Genito-pelvic Pain/Penetration Disorder (GPPD). GPPD requires the following criteria: persistent or recurrent difficulties that result in significant distress with one or more of the following for at least 6 months: 1. Genital penetration during intercourse; 2. Marked vulvovaginal or pelvic pain during vaginal intercourse or penetration attempts; 3. Marked fear or anxiety about vulvovaginal or pelvic pain in anticipation of, during, or as a result of vaginal penetration; and 4. Marked tensing or tightening of the pelvic floor muscles during attempted vaginal penetration [30].

PDI and Depression

Women who experience PDI regardless of whether they have sought or received a diagnosis, are more likely to suffer from general psychological distress, and, in particular, increased depressive symptoms [15, 31-33]. A number of cross-sectional studies reveal that genital PDI was related to increased depressive symptoms [12-14, 34-45]; however, several studies show little to no direct relationship between painful intercourse, and/or vaginal/vulvar complaints, and depressive symptoms [46-49].

In longitudinal studies, PDI has been shown to predict increases in depression or depressive symptoms [50]. However, the directionality remains unclear, as there is often conflicting evidence. For instance, Khandker and colleagues [31] found that vulvodynia increases the risk of new and recurrent onset of a mood disorder but also found that a diagnosed depressive disorder (DSM-IV) was an independent predictor for developing vulvodynia. These findings highlight the possibilities of 1) a bidirectional temporal relationship between PDI and depressive symptoms, potentially depending on which disorder occurs first, and 2) the possibility of a third variable, such as negative affectivity

or neuroticism, explaining both symptoms. Although the strong relationship between PDI and depressive symptoms has been previously documented, the directionality and potential mechanisms of this relationship have yet to be clarified. Identifying the mechanisms, moderators, and directionality of the PDI-depression relationship is important because this could provide us with potential targets for interventions. Clarifying moderators of this relationship will help researchers and clinicians to determine for whom depression might cause sexual dysfunction or PDI, and for whom PDI might cause depression. Clarifying mechanisms can help to tailor effective interventions to prevent or treat the resulting symptoms.

Potential Mechanisms of the PDI-Depression Relationship

Previous research suggests that partner responses to genital PDI can influence women's depressive symptoms [51]. Research also suggests that loneliness might be an important factor in the context of chronic genital PDI in women, as such loneliness is the primary mechanism of focus for this thesis.

Definition and Theories of Loneliness. Loneliness, or the perceived lack of social connectedness, has important psychological and physical health implications. Loneliness researchers argue that social isolation and loneliness are separate constructs. Social isolation is an objective indicator of a lack of social connections, while loneliness is a subjective experience, the dissonance between an individual's current perceived and preferred state of social connectedness [52]. Having fewer social connections does not tend to strongly correlate with self-reported loneliness [53], suggesting that fewer social connections, or friends, does not make individuals more lonely. The current study adopted the most widely accepted definition of loneliness, the *subjective* rather than

objective lack of social support and connectedness [54]. Perceived social isolation predicts a variety of health complications, including all-cause mortality [55, 56], reductions in physical activity [57], and increased blood pressure [58].

Loneliness and Depression. The relationship between loneliness and depression is well-established. Longitudinal studies show that loneliness predicted increases in depressive symptoms among children, adolescents, college freshmen, adults, the elderly, and patients with cancer, HIV, and fibromyalgia [54, 59-70]. Lonelier individuals also tend to have higher rates of sleep disturbance and engage in less physical activity, two factors that are related to increased pain and depressive symptoms [62, 63, 71-74].

The Missing Link: Pain during Intercourse and Loneliness

Although women who experience PDI and/or loneliness may be more likely to experience depressive symptoms, the relationship between PDI and loneliness remains unclear. Currently, only one study has examined the relationship between PDI and loneliness. Stout and colleagues [35] found a positive cross-sectional correlation between PDI and loneliness, and analyses suggested that PDI had indirect effects on depressive symptoms via loneliness. However, cross-sectional data cannot provide true tests of mediation. Thus, the present study aims to expand these findings using longitudinal data to elucidate the temporal relationships between these variables. Measuring symptoms over time can help with establishing the Bradford Hill temporality criterion for causality (i.e. Criterion 4: the causal variable manifests in time before the onset of the outcome variable [75]). This temporality step is a logical follow-up given the previous work demonstrating that our key study variables are strongly (Criterion 1) and consistently (Criterion 2) related to one another, cross-sectionally.

Despite the lack of explicit prospective examinations of loneliness in relation to PDI, theoretical links between PDI and loneliness have been documented. In a qualitative study by Connor and colleagues among women dealing with vulvar pain and their male partners, a common theme that emerged was women feeling socially isolated and less connected to their partners [76]. Even though this study used the term social isolation, they defined it as social connectedness, suggesting that this variable was closely related to loneliness, subjective feelings of connectedness (i.e. the quality of one's relationships) [52].

There are several factors that might explain why women who experience PDI might also report greater loneliness. Some of these have been synthesized below into theoretical models that help guide the discussion of the relationship between PDI and loneliness. First is the Communal Coping Model of Pain [77]. This model emphasizes the importance of communicating pain-related distress to important others to receive needed or desired support and care. Research suggests that women have difficulty communicating about PDI with sexual and romantic partners [78-81] for reasons ranging from fear of partner's response [79] to wanting to feel normal [78, 81]. These findings suggest that the reactions or perceived reactions from sexual or romantic partners play an important role in the psychosocial and sexual outcomes in women who experience PDI, including their experience of loneliness.

In addition to difficulties discussing pain with their partners, women who experience PDI may also feel discomfort sharing their experience of PDI with their close friends or acquaintances [80, 82]. Women also report discomfort related to discussing their sexual functioning with physicians [83, 84]. One study found that 39% of women

with vulvodynia symptoms did not seek treatment [42], and another [85] indicated that a majority of sampled patients never sought medical help for their sexual dysfunction, and 26% explained that fear of stigma was the reason. If women are unable to share their experiences with important others, this means they may not be receiving the medical care or social support they need, and thus increasing feelings of perceived social isolation (loneliness).

Next, Loneliness Theory describes a pattern of cognitions and behaviors that can increase and maintain loneliness. Lonelier people tend to have more negative social cognitions or negative expectations of others, which can then lead to more negative interactions with others, and these interactions can maintain negative social cognitions [86]. Further, social connectedness, or the quality of one's social support, also plays a role in increased loneliness and negative social cognitions [86]. Evolutionarily, lonely individuals feel less safe than those who are not lonely, which can increase their sensitivity to threats and increase self-protective behaviors, such as taking steps to prevent rejection [87]. Drawing from Loneliness Theory [86], women who experience PDI might think that their partners, friends, or physicians might react in a negative way or might judge them if they bring up their pain (negative social cognitions/expectations). These negative cognitions might negatively affect their behavior around others, which can maintain the cycle of negative cognitions and behaviors, and thus, increase their feelings of loneliness.

Potential Moderating Factors

In addition to examining loneliness as a potential mediator of the PDI-depression relationship, several factors may serve as moderators. First, relationship satisfaction plays

an important role in the relationship between PDI and depressive symptoms. Research links relationship dissatisfaction with depressive symptoms in women with PDI [88-91]. Further, relationship satisfaction is significantly related to sexual satisfaction [7, 8, 91, 92], and a variety of studies link sexual dissatisfaction with depressive symptoms [6, 88]. Second, sexual abuse is a risk factor for sexual dysfunction and PDI [39, 49, 93-95]. Finally, pain catastrophizing has been shown to be related to depressive symptoms in variety of chronic pain samples [77, 96]. Pain catastrophizing describes pain-related cognitive processes, including three components: rumination, ("I cannot stop thinking about the pain"), magnification ("This pain is the worst"), and helplessness ("There is nothing I can do about the pain") [97]. Importantly, studies among women with provoked vestibulodynia (PVD) have shown that pain catastrophizing is related to increased severity of genital pain [98, 99].

Current Study

The overarching goals of this study were to examine the temporal relationships between pain during intercourse (PDI), loneliness, and depressive symptoms among women. In addition, this study aimed to explore potential moderators (i.e., relationship satisfaction, sexual abuse history, and pain catastrophizing) that may impact the relationship between PDI and depressive symptoms or PDI and loneliness. This study advances the literature by expanding upon the findings from previous work on the PDI-loneliness-depression relationship, including a 2018 cross-sectional pilot study [35]. The current investigation uses a longitudinal design (over six months) to provide stronger evidence in support of loneliness as a mechanism in the relationship between PDI and depressive symptoms. To begin, cross-sectional associations between these variables

were examined to replicate the findings of the pilot study [1] and confirm that relationships between PDI, loneliness, and depressive symptoms exist in a different sample when examined in a single time point. Next, the examination of the longitudinal associations between these variables allowed us to more accurately infer causation between PDI and later depressive symptoms by controlling for baseline depression. Specifically, the following aims were examined:

Aim 1 – To test the hypotheses that PDI, loneliness, and depressive symptoms will be positively correlated with one another at baseline (T1).

Aim 2 – To test the hypotheses that PDI, loneliness, and depressive symptoms (T1) will be positively correlated with 6-month follow-up depressive symptoms at Time 2 (T2) and with change in depressive symptoms (T2-T1).

Aim 3 – To test the hypothesis that loneliness will mediate the relationship between baseline PDI and change in depressive symptoms (Figure 1).

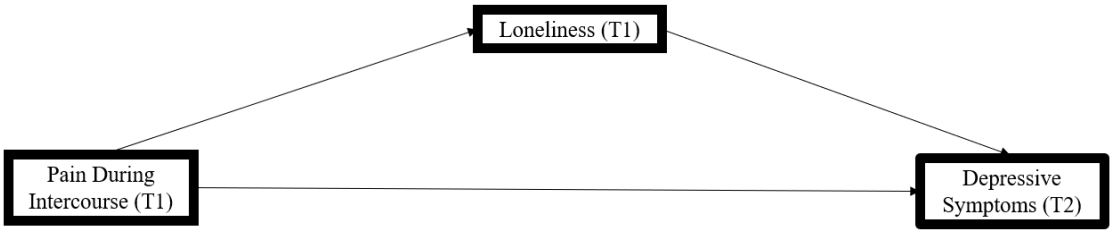

Fig. 1. Theoretical model of the hypothesized relationships between primary variables

Exploratory Aim – To explore potential moderators (relationship satisfaction, history of sexual abuse, and pain catastrophizing) within the above-described relationships (Figure 2). Based on previous literature, these variables are expected to moderate the direct relationship between PDI and depressive symptoms (path

c). However, given the lack of research with loneliness as a mediator in the relationship between PDI and depressive symptoms, it is possible that these variables might moderate the relationship between PDI and loneliness (path a).

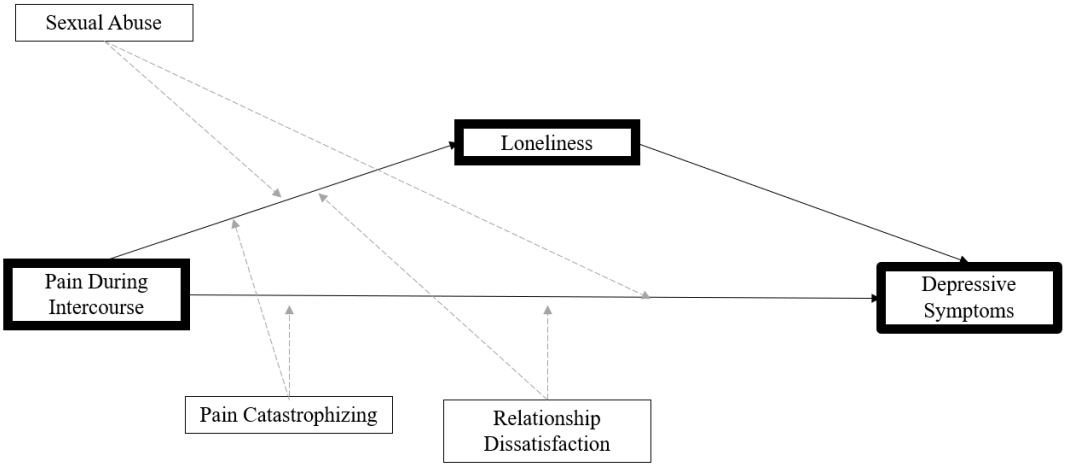

Fig. 2. Theoretical model of the hypothesized relationships between primary variables and exploratory moderators

CHAPTER II

METHODS

Participants

Participants were recruited from Amazon Mechanical Turk (Mturk) and SONA, both online research participation platforms. Participants had to meet the following inclusion criteria: 1) biologically female, of any gender identity, 2) 18 years of age or older, and 3) have experienced consensual, vaginally penetrative sexual intercourse in their lifetime. Throughout the present study, sexual intercourse was defined as follows: Activity with another individual in which the vaginal cavity is penetrated by an object or body part for sexual purposes. Therefore, non-consensual sex, acts of self-stimulation/masturbation, or penetration by non-sexual object (i.e., tampons) were not considered consensual sexual intercourse. All measures completed by participants are described below and the actual items are included in Appendix B. Participants first completed demographic and sexual functioning items, and the remainder of the scales were presented in random order.

Data were collected via online survey on Mturk in addition to SONA for a variety of reasons. First, the sensitive nature of the questions and topics covered might have deterred students from participating, and thus limiting the number of respondents.

Further, symptoms of vulvodynia tend to begin between the ages of 18 and 25 years [100]. Given that SONA participants are largely first-year undergraduates (e.g., average participant age is typically around 19 years [101]), an Mturk sample was more likely to increase diversity and generalizability compared to the SONA participant pool.

Measures

Sexual Function and Behaviors (T1 Predictor). The Female Sexual Function Inventory (FSFI) [102] is a 19-item inventory that measures sexual function in the following areas: interest and arousal, confidence, lubrication, orgasm, emotional closeness, and discomfort in the last 4 weeks and the participant's lifetime. Items in this inventory are summed to provide a total value for sexual functioning. This value ranges from 19 to 95, where lower values represent poorer sexual functioning. Of particular interest to the current study, the FSFI provided three summed items relating to frequency of discomfort or pain during and following intercourse (1 = almost always or always to 5 = almost never or never), and degree of pain during or following intercourse (1 = very high to 5 = very low or none at all). All items in this inventory are scored from 0 to 5, where 0 is "no sexual activity" or "did not attempt intercourse", 1 is varying responses related to low sexual functioning (very high, almost always or always etc.), and 5 is varying responses related to severity and frequency of different aspects of sexual functioning (e.g., very low, almost never or never etc.). To reduce participant burden, the 0 responses were eliminated and a screening item was added to the beginning of the survey section, such that participants who reported that they had not had sexual intercourse (as defined by the current study) in the past 4 weeks or in their lifetime did not receive this inventory. For analyses, the discomfort items were reverse coded, so that

higher total scores represent more severe and/or frequent discomfort. In the present sample, the pain subscale of the FSFI demonstrated good internal consistency (α=.83).

Depressive symptoms (Outcome) (T1 and T2). The 8-item Patient Health Questionnaire (PHQ8) was used as a measure of depressive symptoms. Participants rated from (0 = not at all to 3 = nearly every day) the frequency at which they experienced depressive symptoms in the past 2 weeks, including loss of interest, feeling down, sleep disturbance, loss of energy, appetite changes, feeling like a failure, difficulty concentrating, and psychomotor agitation or retardation. The responses were summed with a possible range of 0 to 24, where higher values represent more severe depressive symptoms. Additionally, the PHQ8 included one item assessing how difficult the listed depressive symptoms interfered with their daily life tasks, in other words, how interfering these symptoms have been, from (0 = not at all difficult to 3 = extremely difficult). None of the items assess for loneliness, social connectedness, or social isolation. The PHQ8 has shown good reliability in a variety of samples, including patients with chronic heart failure (α=.82) [103]. In the present sample, this scale demonstrated good internal consistency (α=.90).

The ninth item of the PHQ9, which assesses suicidal ideation, was excluded. To counteract this exclusion, suicide prevention and counseling resources were provided to all participants who scored in the moderately severe or severe range (≥10) for depressive symptoms [104]. A PHQ8 score of ≥10 typically indicates significant depressive symptoms, and has 88% sensitivity and 88% specificity for detecting major depression [105]. The PHQ8 was administered as baseline and follow-up in order to account for the influence of depressive symptoms at T1 on follow-up depression at 6-month follow-up.

Change in depression score was calculated by subtracting T1 from T2 (change=T2-T1), such that a negative score would indicate a decrease in depressive symptoms.

Loneliness (T1 Mediator). The UCLA Loneliness Scale (ULS) [106] version 3 is a 20-item self-report measure of loneliness [106]. Participants rated the frequency at which they experienced feelings of loneliness and social connectedness (1 = never to 4 = always). After reverse scoring nine of the items, responses were summed for a total score with a possible range of 20 to 80, with higher scores indicating greater loneliness. The ULS has shown good reliability in college students (α=.92), nurses (α=.94), and the elderly (α=.89) [106]. This scale demonstrated good internal consistency in the present sample (α=.96).

Anxious Symptoms (T1 Auxiliary Variable). The 7-item Generalized Anxiety Disorder (GAD7) was used to measure symptoms of anxiety. Participants rated from (0 = not at all to 3 = nearly every day) the frequency at which they experienced depressive symptoms in the past 2 weeks, including nervousness/feeling on edge, frequent and uncontrollable worry, difficulty relaxing, restlessness, irritability, and fear of something awful happening. The responses were summed with a possible range of 0 to 21, where higher values represent more severe depressive symptoms. Additionally, the GAD7 included one item assessing how difficult the listed symptoms of anxiety interfered with their daily life tasks, in other words, how interfering these symptoms have been, from (0 = not at all difficult to 3 = extremely difficult). The GAD7 has shown good reliability in a variety of samples, (α=0.92) [107], and in the present sample (α=.95).

Demographic information (T1). Participants were asked demographic questions, including age, gender identity, race, ethnicity, relationship status, sexual orientation,

history of mental health diagnoses, and history of medical diagnoses (including the following STIs: chlamydia, condylomas, and genital herpes).

Potential Moderators. Several variables were assessed as potential, exploratory moderators of the relationships between genital pain, depression, and loneliness, including relationship satisfaction, pain catastrophizing, and history of sexual abuse.

Relationship Satisfaction (T1). The Relationship Assessment Scale (RAS) [108] is a 7-item measure of relationship satisfaction. Using a 5-point Likert-type scale, the RAS assessed multiple aspects of relationships including: how well their partner meets their needs, how satisfied they are with the relationship, how good the relationship compared to most others, how often they wish they had not gotten into the relationship, how much the current relationship met their original expectation, how much love they have for their partner, and the amount of problems in the relationship. Two items are reverse scored, and then all items are summed and divided by 7 to get a mean score. Higher scores indicate more general relationship satisfaction. The RAS shows good test-retest reliability (α=.85) [108]. In the current sample, the RAS demonstrated good internal consistency (α=.92).

History of Sexual Abuse (T1). Participants' history of sexual abuse was assessed, including unwanted sexual contact, sexual coercion, attempted rape, and rape, as well as their age at the time of the abuse. The history of sexual abuse variable was coded as (0 = no, 1 = yes).

Pain Catastrophizing (T1). The Pain Catastrophizing Scale (PCS) [97] is a 13-item measure of pain catastrophizing, which includes three subscales: rumination, magnification, and helplessness. Participants were asked to report the frequency from (0

= not at all to 4 = all the time) at which they experience catastrophic cognitions related to pain, such as “I can’t seem to keep it out of my mind” (rumination), “It’s awful and I feel that it overwhelms me,” (magnification), and “There’s nothing I can do to reduce the intensity of the pain” (helplessness). Scores on the PCS were summed to create total and subscale scores, where higher values represent more catastrophizing. Scores greater than or equal to 30 are considered clinically significant catastrophizing. The PCS and its subscales have shown moderate-to-good reliability (αs; PCS total=.87; rumination=.87, magnification=.66, helplessness=.78) [97]. PCS demonstrated good reliability in the current sample (α=.96).

Procedure

Participants accepted a HIT (or Human Intelligence Task) through Mturk or signed up on SONA for a two-part online confidential Qualtrics survey. First, participants read an online consent form and agreed to participate in a two-part study. Given the potentially sensitive nature of the items, during the survey participants were reminded twice that their responses were anonymous and were not connected to their name or email address. At the end of the Part 1 survey, the participants were given a randomly generated ID from 0 to 9,999,999,999 and re-directed to a separate Qualtrics survey, housed in a separate Qualtrics account. Participants were asked to paste the code into the new survey, then fill out their contact information for Part 2 of the survey. The identifying and contact information were housed in a separate Qualtrics account to protect participant privacy. Though unlikely, if one Qualtrics account was accessed by a non-authorized person, they would have access to unidentified survey responses or contact information, but not both.

Baseline surveys were completed between November 2018 and January 2019. Approximately 6 months later after participants completed T1, T2 surveys were sent out in weekly batches from April 2019 to June 2019. After completing the baseline T1 survey, Mturk participants were compensated $3.00, while SONA participants received credit for a 1-hour study. For the T2 survey, MTurk participants were compensated $5.00, and SONA participants were entered into a drawing to win a $25.00 Amazon gift card.

Data Analysis

Power Analysis. A power analysis was conducted using MedPower [109] to determine the sample size needed for the present study. Standardized regression coefficients from a mediation analysis conducted in a pilot study [35] of 104 female college student participants were used to conduct post-hoc power analyses for all primary variables: $\beta_{\text{path a}} = 0.372$, $\beta_{\text{path b}} = 0.209$, $\beta_{\text{path c'}} = 0.124$. The final power analysis was based on the computed effect size d = 0.078, and final results indicated that a sample size of 198 people would be needed to have an 80% chance of detecting a small effect (≥0.078) at α=0.05 level. This power analysis was conservative, given that the analyses used 5,000 bootstrapped re-samples. In order to account for attrition, attempts were made to over-recruit by 74 participants, totaling 272 female participants who report having sexual intercourse (as defined by the current study) in their lifetime. This value was derived based on suggestions by Christenson and Glick [110] who found that around 37% of MTurk participants did not complete their 4-month follow-up survey.

Primary Analyses for Aims 1-3. First, descriptive statistics were collected, including means and standard deviations of the primary study variables (i.e. PDI,

loneliness, and depressive symptoms) and the secondary study variables (relationship satisfaction, pain catastrophizing, and history of sexual abuse). Then, bivariate correlations were conducted to test Aim 1 and 2 hypotheses that baseline PDI, loneliness, and depressive symptoms are positively correlated and that baseline PDI, depression, and loneliness at T1 are positively correlated with follow-up depressive symptoms at T2 and change in depressive symptoms from T1 to T2.

A mediation analysis was conducted using MPLUS [111] to test the Aim 3 hypothesis that loneliness mediated the relationship between baseline PDI and change in depressive symptoms, which helps meet the Bradford Hill Criteria of temporality [75]. In order to do so, depressive symptoms were measured at two different times, 6 months apart, and a change variable was computed (T2-T1) and used as the primary outcome for all subsequent analyses. Such an approach ensures that baseline depressive symptoms are not responsible for observed associations between PDI, loneliness, and change in depressive symptoms because baseline depressive symptoms are accounted for in the change score.

The overall mediated effect was tested, which represents the total indirect effect. The analysis was conducted with 5,000 bootstrapped re-samples. Bootstrapping is a nonparametric procedure, which means that it does not assume that the indirect effect of the independent variable on the dependent variable is normally distributed. Bootstrapping creates multiple smaller datasets using subsets of the collected sample. These datasets empirically represent the sampling distribution, and then re-runs the analyses using the 5,000 (or desired value) re-samples [112, 113]. The total effect (path c) of pain during intercourse on depressive symptoms is represented by the sum of the direct effect of pain

during intercourse (path c') and the indirect effect of PDI on depressive symptoms through the mediator (loneliness) (ab). The effect of PDI on loneliness is represented by path a, and the effect of loneliness on depressive symptoms is represented by path b. All variables were modeled as measured variables.

A confidence interval for a mediation analysis is derived using the k estimates, or values that estimate the sampling distribution of the indirect effect. These k values are sorted in numerical order, and lower and upper bounds are represented by the values in the 2.5th and 97.5th percentiles, respectively [112]. In the current study, a 99% confidence interval was used to determine whether the mediation analysis is significant. I chose this instead of 95% to correct for multiple comparisons. If zero is not contained within the confidence interval, the analysis is considered significant. This is similar to rejecting the null hypothesis. In this case, the null hypothesis is: H0 – There is no indirect effect of pain during intercourse on depressive symptoms through loneliness.

Secondary Analyses for Exploratory Aim. Conditional indirect effects, or moderated mediation, were run using the PROCESS macro in SPSS to test the Exploratory Aim examining potential moderators of the above-described mediation model. As the crux of this project was to examine the longitudinal effects of PDI and loneliness on depressive symptoms, change in PHQ8 was used as the outcome variable for moderated mediation analyses.

In moderated mediation, the direct effect of the independent variable on a dependent variable depends on the value of the moderator variable. These relationships can increase in strength, decrease in strength, or change directions after considering the effect of the moderator. More specifically, a moderator can change the relationship

between the predictor and mediator (path a), between the mediator and outcome (path b), or between the predictor and outcome variable (path c'). Exploratory analyses examined the following possible moderators: relationship satisfaction, history of sexual abuse, and pain catastrophizing.

Covariates. Race was selected as an important covariate given that research suggests that patients with chronic pain are perceived and treated differently in medical settings based on race. Specifically, Black patients and patients of color often receive poorer quality care than white patients [114, 115]. There are also psychosocial factors (i.e. rumination) that play a role in both race and sex differences in pain perception and appraisals of control that are likely impacted by inadequate care or potentially harmful interactions with physicians [116-118]. Generally, the scientific community is moving away from using race as a covariate, and instead measuring specific and relevant outcomes of systemic racism such as daily experience of microaggressions or discrimination. Unfortunately, this present study did not include any measures of racism, so race was used a proxy. More details on alternatives to race as a covariate are included in the future directions section of the discussion.

Missing Data Approach. To minimize missing data, participants received a prompt if they had any unanswered items before progressing to the next page. Per the recommendations of Meade and Craig [119], several methods were employed to detect random or careless responding. First, three validation items were included in the survey to ensure that participants responded in a valid fashion. These items were distributed throughout the survey to covertly detect for careless responding. Items instructed participants to respond a certain way on items (e.g., "Respond with 'strongly agree' for

this item"). Finally, a self-report item was included at the end of the survey, asking the participant, "In your honest opinion, should we use the data you provided in this survey?"

Auxiliary Variables. Two variables were chosen *a priori* based on recommendations from Enders [120] to serve as auxiliary variables in the maximum likelihood missing data approach: age and GAD7. These auxiliary variables were used in all of the below analyses in MPLUS. Using auxiliary variables can improve the accuracy of your maximum likelihood estimate and are often conceptualized as a "cause" of the missing data [120]. The bootstrapping technique used in the analyses estimated the maximally likely responses for these missing items based on all the subjects' observed responses.

CHAPTER III

RESULTS

Data Cleaning and Validation

All data were reviewed before analyses were conducted to ensure that they were complete and meet assumptions for a simple mediation analysis. A total of 343 individuals responded to the survey, and a total of 113 records were eliminated from the dataset for the following reasons: 5 individuals were deleted from the dataset for reporting male biological sex; 22 individuals were eliminated from the dataset for not completing the demographics portion of the survey (i.e., completed fewer than 10 items); 52 individuals were excluded for not responding to at least 2 of the 4 validity questions; 27 individuals were excluded for not responding in a valid fashion; and 7 individuals were excluded for responding to the survey more than once (with different responses). Upon final data cleaning, a complete sample of 230 individuals with valid responding was retained.

Participants

Participants were all assigned female at birth, were on average 34.25 ± 13.7 years old, 79.1% white, 86.1% heterosexual, 63.9% were partnered, and 97.8% identified as women (see Table 1). MTurk and SONA samples differed significantly on age,

relationship status, and level of education, with MTurkers being older, more likely to be partnered, and having more education (see Table 1). As attrition was large in the present study between survey 1 (n=230) and survey 2 (n=107), Table 2 includes differences in participant demographics between completers and non-completers. Notably, there were no significant differences in pain severity or frequency between sampling groups (Table 3) or between completers and non-completers (Table 4).

Table 1. Baseline Differences by Sampling Group

	Sampling Group			
	All (n = 230)	MTurk (n =159)	SONA (n = 71)	p
Demographic Factors				
Age	34.25 [13.7]	40.52 [11.6]	20.20 [4.5]	**<.001**
Gender identity				
Woman	225 (97.8%)	155 (97.5%)	70 (98.6%)	.967
Non-binary	3 (1.3%)	2 (1.3%)	1 (1.4%)	
Man	1 (0.4%)	1 (0.6%)	-	
Choose not to respond	1 (0.4%)	1 (0.6%)	-	
Race				.684
White/Caucasian	182 (79.1%)	128 (80.5%)	54 (76.1%)	
More than one race	19 (8.3%)	10 (6.3%)	9 (12.7%)	
Black/African American	15 (6.5%)	12 (7.5%)	3 (4.2%)	
Latinx	5 (2.2%)	3 (1.9%)	2 (2.8%)	
Asian	5 (2.2%)	5 (3.1%)	-	
American Indian/Alaska Native	3 (1.3%)	1 (0.6%)	2 (2.8%)	
Middle Eastern/North African	1 (0.4%)	-	1 (1.4%)	
Relationship Status - Partnered[a]	147 (63.9%)	120 (75.5%)	42 (59.2%)	**.018**
Sexual Orientation				.274
Heterosexual	198 (86.1%)	133 (83.6%)	65 (91.5%)	
Bisexual	25 (10.9%)	21 (13.2%)	4 (5.6%)	
Homosexual	4 (1.7%)	3 (1.9%)	1 (1.4%)	
Other Sexuality	4 (1.7%)	2 (1.3%)	2 (2.8%)	
Highest level of education				**<.001**
High school or GED	18 (7.8%)	18 (11.3%)	-	
Technical school	7 (3.0%)	6 (3.8%)	1 (1.4%)	
Some college/Associates degree	136 (59.1%)	62 (39.0%)	64 (90.1%)	
Bachelor's degree	62 (27%)	57 (35.8%)	5 (7.0%)	
Graduate degree	17 (7.4%)	16 (10.1%)	1 (1.4%)	
Relevant Medical or Psychiatric Diagnoses				
Chronic Pelvic Pain	1 (0.4%)	1 (0.6%)	-	
GPPD/vaginismus/dysparuenia	-	-	-	
Pre-menstrual dysphoric disorder	1 (0.4%)	1 (0.6%)	-	
Depression	79 (34.3%)	60 (62.3%)	19 (26.8%)	.096
Anxiety	89 (38.7%)	69 (43.4%)	20 (28.2%)	**.020**

Female Sexual Function Index – Lifetime Prevalence				
Pain	5.67 [2.7]	5.79 [2.7]	5.41 [2.6]	.311
Desire	6.9 [1.6]	6.86 [1.7]	7.00 [1.5]	.589
Arousal	15.32 [3.4]	15.16 [3.6]	15.69 [2.7]	.273
Lubrication	17.14 [3.0]	17.15 [2.9]	17.11 [3.2]	.926
Orgasm	9.94 [3.4]	10.15 [3.4]	9.48 [3.4]	.172
Satisfaction	11.76 [3.1]	11.51 [3.3]	12.33 [2.5]	**.040**
***Female Sexual Function Index – 4 week Prevalence* (*n*s =144,94,50)**				
Pain	5.31 [3.2]	5.22 [3.3]	5.46 [3.1]	.678
Desire	6.98[2.0]	6.72 [2.0]	5.46 [3.1]	**.031**
Arousal	15.69 [3.9]	15.31 [4.2]	16.40 [3.1]	.082
Lubrication	17.18 [3.4]	17.24 [3.5]	17.06 [3.0]	.754
Orgasm	10.87 [3.8]	11.25 [3.5]	10.14 [3.6]	.092
Satisfaction	12.53 [3.1]	12.20 [3.4]	13.16 [2.2]	**.046**
Psychosocial Symptoms				
Patient Health Questionnaire-8	5.59 [5.6]	5.10 [5.3]	6.69 [6.0]	**.049**
Somatic	2.96 [2.5]	2.69 [2.4]	3.58 [2.8]	**.014**
Cognitive	2.65 [3.5]	2.47 [3.4]	3.07 [3.7]	.228
UCLA Loneliness Scale	41.56 [13.9]	42.8 [14.8]	38.81 [11.3]	**.028**
Generalized Anxiety Disorder-7	14.08 [6.7]	13.32 [6.5]	15.81 [6.8]	**.009**
Covariates				
History of Sexual Abuse				.937
Yes	103 (44.8%)	73 (45.9%)	33 (46.5%)	
Choose not to respond	3 (1.3%)	3 (1.9)	0	
Pain catastrophizing scale	24.38 [12.0]	24.95 [12.3]	23.13 [11.2]	.288
Rumination	8.61 [4.8]	8.89 [5.0]	7.99 [4.4]	.168
Magnification	5.70 [2.9]	5.78 [2.9]	5.52 [3.1]	.539
Helplessness	10.10 [5.1]	10.29 [5.3]	9.62 [4.5]	.358
Relationship satisfaction (n=147, 118, 29)	4.15 [0.85]	4.11 [0.9]	4.27 [0.7]	.380

Note. Data are presented using *M* [*SD]* or *n* (%).
[a]married, living with partner, or in a serious relationship

Table 2. Baseline Differences in Completers and Non-Completers

		Sampling Group		
	All (*n* = 230)	Completers (*n* =107)	Non-Completers (*n* = 123)	*p*
Group				
Amazon Mechanical Turk	159 (69.1%)	92 (86.0%)	67 (54.5%)	
Psychology Subject Pool (SONA)	71 (30.9%)	15 (14.0%)	56 (45.5%)	
Demographic Factors				
Age	34.25 [13.7]	39.56 [14.0]	29.63 [11.6]	**<.001**
Gender identity				

Woman	225 (97.8%)	103 (88.0%)	122 (99.2%)	
Non-binary	3 (1.3%)	2 (1.7%)	1 (0.8%)	
Man	1 (0.4%)	1 (0.9%)	-	
Choose not to respond	1 (0.4%)	1 (0.9%)	-	
Race				.350
White/Caucasian	182 (79.1%)	84 (78.5%)	98 (79.7%)	
More than one race	19 (8.3%)	8 (7.5%)	11 (8.9%)	
Black/African American	15 (6.5%)	7 (6.5%)	8 (6.5%)	
Latinx	5 (2.2%)	3 (2.8%)	2 (1.6%)	
Asian	5 (2.2%)	2 (1.9%)	3 (2.4%)	
American Indian/Alaska Native	3 (1.3%)	3 (2.8%)	-	
Middle Eastern/North African	1 (0.4%)	-	1 (0.8%)	
Relationship Status - Partnered[a]	147 (63.9%)	74 (69.2%)	88 (71.5%)	.694
Sexual Orientation				.814
Heterosexual	198 (86.1%)	91 (85.0%)	106 (86.2%)	
Bisexual	25 (10.9%)	12 (11.2%)	13 (10.6%)	
Homosexual	4 (1.7%)	2 (1.9%)	2 (1.6%)	
Other Sexuality	4 (1.7%)	2 (1.9%)	2 (1.6%)	
Highest level of education				**.**105
High school or GED	18 (7.8%)	14 (13.0%)	19 (15.4%)	
Technical school	7 (3.0%)	2 (1.9%)	5 (4.1%)	
Some college/Associates degree	136 (59.1%)	49 (45.8%)	62 (50.4%)	
Bachelor's degree	62 (27%)	31 (29.0%)	31 (25.2%)	
Graduate degree	17 (7.4%)	11 (10.3%)	6 (4.9%)	
Relevant Medical or Psychiatric Diagnoses				
Chronic Pelvic Pain	1 (0.4%)	1 (0.9%)	-	
GPPD/vaginismus/dysparuenia	-	-	-	
Pre-menstrual dysphoric disorder	1 (0.4%)	1 (0.9%)	-	
Depression	79 (34.3%)	40 (37.4%)	39 (31.7%)	.368
Anxiety	89 (38.7%)	50 (46.7%)	39 (31.7%)	**.020**
Female Sexual Function Index – Lifetime Prevalence				
Pain	5.67 [2.7]	5.80 [2.6]	5.56 [2.7]	.490
Desire	6.9 [1.6]	6.82 [1.8]	7.00 [1.5]	.501
Arousal	15.32 [3.4]	15.09 [3.8]	15.52 [3.0]	.351
Lubrication	17.14 [3.0]	17.20 [3.1]	17.10 [2.9]	.816
Orgasm	9.94 [3.4]	9.90 [3.6]	10.00 [3.3]	.848
Satisfaction	11.76 [3.1]	11.78 [3.2]	11.75 [3.0]	.942
***Female Sexual Function Index – 4 week Prevalence* (*n*s =144, 58, 86)**				
Pain	5.31 [3.2]	5.16 [3.2]	5.41 [3.3]	.648
Desire	6.98[2.0]	6.43 [2.]	7.35 [1.8]	**.005**
Arousal	15.69 [3.9]	14.76 [4.2]	16.31 [3.6]	**.019**
Lubrication	17.18 [3.4]	17.07 [3.5]	17.26 [3.3]	.744
Orgasm	10.87 [3.8]	10.53 [4.0]	11.09 [3.6]	.387
Satisfaction	12.53 [3.1]	11.8 [3.5]	13.02 [2.7]	**.029**
Psychosocial Symptoms				
Patient Health Questionnaire-Depressive	5.59 [5.6]	5.82 [5.8]	5.39 [5.3]	.568
Somatic	2.96 [2.5]	3.06 [2.6]	2.90 [2.4]	.504
Cognitive	2.65 [3.5]	2.82 [3.7]	2.51 [3.3]	.590

UCLA Loneliness Scale	41.56 [13.9]	41.98 [14.3]	41.20 [13.6]	.675
Generalized Anxiety Disorder-7	14.08 [6.7]	13.94 [7.1]	14.20 [6.3]	.769
Covariates				
History of Sexual Abuse				.058
Yes	103 (44.8%)	46 (43.0%)	60 (48.8%)	
Choose not to respond	3 (1.3%)	1 (0.9%)	2 (1.6%)	
Pain catastrophizing scale	24.38 [12.0]	24.70 [12.2]	24.10 [11.8]	.704
Rumination	8.61 [4.8]	8.92 [5.0]	8.34 [4.7]	.373
Magnification	5.70 [2.9]	5.62 [3.0]	5.77 [2.9]	.690
Helplessness	10.10 [5.1]	10.19 [5.2]	9.98 [5.0]	.759
Relationship satisfaction (*n*s=147, 70, 77)	4.15 [0.85]	4.03 [0.9]	4.25 [0.8]	.113

Note. Data are presented using *M* [*SD]* or *n* (%).
[a]married, living with partner, or in a serious relationship

Table 3. Vaginal PDI Frequency and Severity by Sampling Group

		Group		
	All (*n* = 230)	MTurk (*n* =159)	SONA (*n* = 71)	*p*
Pain – Ever				
Frequency during	1.97 [1.0]	2.00 [1.0]	1.90 [1.0]	.498
Frequency after	1.84 [1.0]	1.89 [1.0]	1.73 [0.9]	.258
Severity	1.9 [0.9]	1.91 [0.9]	1.77 [0.9]	.321
***Pain – 4-Weeks (n*s=144,94,50)**				
Frequency before	1.58 [0.9]	1.60 [1.0]	1.56 [0.8]	.828
5- Almost always or always	2 (1.4%)	1 (0.7%)	1 (0.7%)	
4- Most times	6 (4.2%)	6 (4.2%)	0 (0.0%)	
3-Sometimes (half the time)	15 (10.4%)	10 (6.9%)	5 (3.5%)	
2-A few times	28 (19.4%)	14 (9.7%)	14 (9.7%)	
1-Almost never or never	93 (64.6%)	63 (43.8%)	30 (20.8%)	
Frequency after	1.54 [0.9]	1.55 [1.0]	1.52 [0.9]	.841
5- Almost always or always	2 (1.4%)	1 (0.7%)	1 (0.7%)	
4- Most times	7 (4.9%)	6 (4.2%)	1 (0.7%)	
3-Sometimes (half the time)	12 (8.3%)	7 (4.9%)	5 (3.5%)	
2-A few times	25 (17.4%)	16 (11.1%)	9 (6.3%)	
1-Almost never or never	98 (68.0%)	64 (44.4%)	34 (23.6%)	
Severity	2.18 [1.7]	2.07 [1.7]	2.38 [1.8]	.310
5-Very high	0 (0.0%)	0 (0.0%)	0 (0.0%)	
4-High	3 (2.1%)	2 (1.4%)	1 (0.7%)	
3-Moderate	16 (11.1%)	11 (7.6%)	5 (3.5%)	
2-Low	29 (20.1%)	16 (11.1%)	13 (9.0%)	
1-Very low of none at all	96 (66.7%)	65 (45.2%)	31 (21.5%)	

Note. Data are presented using *M* [*SD]* or *n* (%).

Table 4. Vaginal PDI Frequency and Severity in Completers and Non-Completers

	Group			
	All (n = 230)	Completers (n =107)	Non-Completers (n = 123)	p
Pain – Ever				
Frequency during	1.97 [1.0]	2.00 [1.0]	1.94 [1.0]	.673
Frequency after	1.84 [1.0]	1.86 [0.9]	1.8 [1.0]	.760
Severity	1.9 [0.9]	1.94 [1.0]	1.80 [0.9]	.228
***Pain – 4-Weeks* (ns =144, 58, 86)**				
Frequency before	1.58 [0.9]	1.60 [1.0]	1.57 [0.9]	.833
5- Almost always or always	2 (1.4%)	1 (0.7%)	1 (0.7%)	
4- Most times	6 (4.2%)	3 (2.1%)	3 (2.1%)	
3-Sometimes (half the time)	15 (10.4%)	5 (3.5%)	10 (6.9%)	
2-A few times	28 (19.4%)	12 (8.3%)	16 (11.1%)	
1-Almost never or never	93 (64.6%)	37 (25.7%)	56 (3.9%)	
Frequency after	1.54 [0.9]	1.55 [0.9]	1.53 [1.0]	.916
5- Almost always or always	2 (1.4%)	1 (0.7%)	1 (0.7%)	
4- Most times	7 (4.9%)	2 (1.4%)	5 (3.5%)	
3-Sometimes (half the time)	12 (8.3%)	5 (3.5%)	7 (4.9%)	
2-A few times	25 (17.4%)	12 (8.3%)	13 (9.1%)	
1-Almost never or never	98 (68.1%)	38 (26.4%)	60 (41.7%)	
Severity	2.18 [1.7]	2.00 [1.6]	2.30 [1.8]	.290
5-Very high	0 (0.0%)	0 (0.0%)	0 (0.0%)	
4-High	3 (2.1%)	1 (0.7%)	2 (1.4%)	
3-Moderate	16 (11.1%)	8 (5.55%)	8 (5.55%)	
2-Low	29 (20.1%)	8 (5.55%)	21 (14.55%)	
1-Very low of none at all	96 (66.7%)	41 (28.5%)	55 (38.2%)	

Note. Data are presented using M [SD] or n (%).

On average at T1, participants endorsed low-to-moderate levels of acute PDI (mean=5.31, SD=3.2; range=3.0-14.0), mild levels of depressive symptoms (mean=5.59, SD=5.6, range=0.0-24.0), and moderate levels of loneliness (mean=41.56, SD=13.9, range=20.0-80.0). Change in depressive symptoms from T1 to T2 was a low increase on average (mean=.67, SD=3.9), but varied widely from increases up to 9 points to decreases of up to 10 points showing adequate variability in the depression change score.

Aim 1: Cross-sectional Bivariate Associations

Greater depressive symptoms at T1 were highly positively correlated with greater loneliness at T1 (r=.590) with large effect sizes (see Table 5). Greater depressive

symptoms at T1 were also positively correlated with greater PDI at T1 (*r*=.255) with a small-to-moderate effect size (see Table 5). Similarly, greater loneliness at T1 showed a moderately sized positive correlation with greater PDI at T1 (*r*=.325) (see Table 5). In sum, all correlations at T1 suggest medium-to-large effects between depressive symptoms, loneliness, and PDI when examined cross-sectionally.

Table 5. Bivariate associations between Key Study Variables

Variable	1	2	3	4
1. Depressive symptoms (PHQ8) T1	-			
2. Depressive symptoms (PHQ8) T2	.779	-		
3. Depressive symptoms change (PHQ8) T2-T1	-.242	.419	-	
4. Loneliness (ULS) T1	.590	.568	.024	-
5. Pain during intercourse (PDI) T1	.255	.272	.051	.325

Note. T1=Time 1; T2=Time 2; PHQ8=Patient Health Questionnaire; ULS=UCLA Loneliness Scale; PDI=Pain During Intercourse.

Aim 2: Prospective Bivariate Associations

Examining the longitudinal correlations, greater depressive symptoms (*r*=.779), loneliness (*r*=.568), and PDI (*r*=.272) at T1 were all positively correlated with greater depressive symptoms at T2 (medium-to-strong effect sizes). When examining change in depressive symptoms from T1 to T2, depressive symptoms at T1 were negatively correlated with depression change score, such that higher T1 depression was associated with smaller changes in depressive symptoms over time (*r*=-.242). In contrast, neither greater loneliness nor PDI at T1 were correlated with change in depressive symptoms (*r*s=.024; .051, respectively). In sum, greater depressive symptoms at baseline were associated with smaller changes in follow-up depressive symptoms, and PDI and loneliness were not linked to depression change scores.

Aim 3: Mediation Analyses

Baseline (replication of cross-sectional pilot study). An indirect effects analysis was run using cross-sectional data collected at baseline to replicate the results of the pilot study [35]. As expected, analyses were significant, suggesting that greater PDI was related to greater loneliness, which was in turn related to greater depressive symptoms. More detailed results can be found in Appendix C. However, given that cross-sectional analyses are not ideal for testing true mediating effects, models were then conducted with the longitudinal data.

Longitudinal (change in depressive symptoms). Two mediation analyses were run using baseline and 6-month follow-up data to examine the mediating role of loneliness in the relationship between PDI at baseline and change in PHQ8 at 6-month follow-up for both pain experienced in the past 4 weeks and lifetime pain. Analyses controlled for race, and age and GAD-7 were used as auxiliary variables.

Model 1: Acute (4-week) Pain. Results of the mediation analysis (Figure 3; Table 6) indicated that loneliness accounted for 10.1% of the variance in model. More severe baseline PDI (past 4 weeks) was associated with greater loneliness (β = .318; 99% CI = .117 to .514). Loneliness was not significantly associated with change in depressive symptoms at 6-month follow-up (β = .034; 99% CI = -.315 to .494). Baseline PDI (past 4-weeks) was not indirectly related to greater follow-up depressive symptoms through loneliness (standardized indirect effect = .011; 99% CI = -.114 to .188). The relationship between baseline PDI (past 4-weeks) and follow-up depressive symptoms was not significant (standardized direct effect = -.040; 95% CI =-.554 to .441).

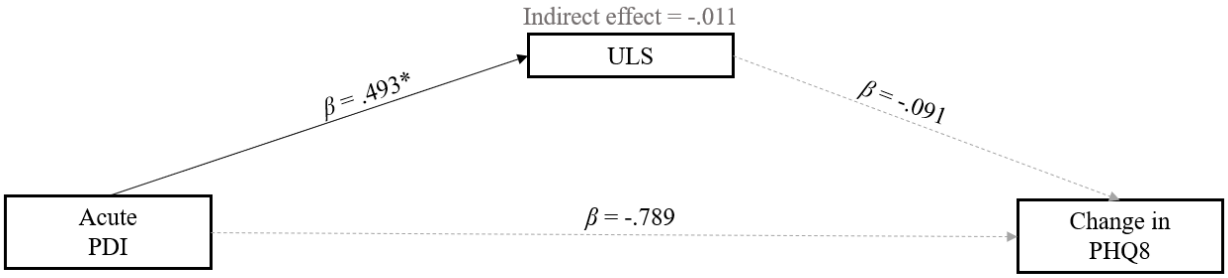

Fig 3. Standardized results of the longitudinal mediation analysis;
Notes. *99% confidence interval does not include zero; PDI=pain during intercourse; ULS=UCLA Loneliness Scale; PHQ8=Patient Health Questionnaire-8 (depressive symptoms)

Model 2: Lifetime Pain. Results of the mediation analysis (Figure 4; Table 6) indicated that loneliness accounted for 14.4% of the model. More severe baseline PDI (lifetime) was associated with greater loneliness (β = .378; 99% CI = .227 to .522). Greater loneliness was not associated with change in depressive symptoms at 6-month follow-up (β = -.050; 99% CI = -.300 to .230). Baseline PDI (lifetime) was not indirectly related to greater depressive symptoms through loneliness (standardized indirect effect = -.019; 99% CI = -.129 to .089). The relationship between baseline PDI and follow-up depressive symptom was also non-significant (standardized direct effect = .031; 95% CI =-.300 to .340).

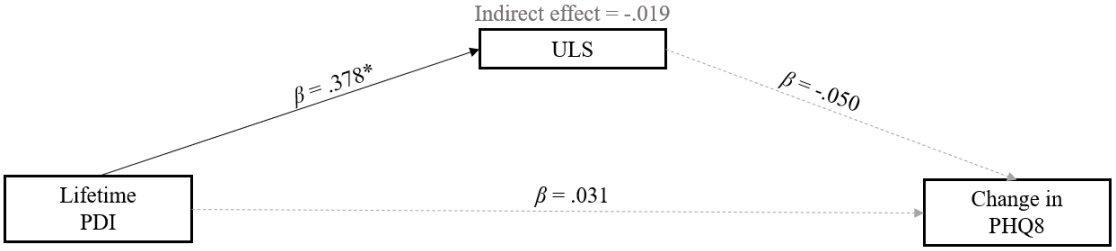

Fig 4. Standardized results of the longitudinal mediation analysis
Notes. *99% confidence interval does not include zero; PDI=pain during intercourse; ULS=UCLA Loneliness Scale; PHQ8=Patient Health Questionnaire-8 (depressive symptoms)

Table 6. Results of Longitudinal Mediation Analyses

	Mediator			Dependent Variable		
	Loneliness			Change in Depressive Symptoms		
Antecedents	β	*SE*	R^2	β	*SE*	R^2
Model 1			0.10			0.003
Intercept	2.227***	0.350		0.253	0.614	
Acute PDI	0.318***	0.007		-0.040	0.200	
Loneliness	-	-	-	0.034	0.159	
Race	0.005	0.075		-0.036	0.094	
				Effect	*SE*	99% CI
Indirect effect of loneliness				0.011	0.054	-0.114 to 0.188
Model 2			0.144			0.007
Intercept	2.321***	0.290		0.468	0.480	
Lifetime PDI	0.378***	0.058		0.031	0.122	
Loneliness	-	-	-	-0.05	0.102	
Race	-0.038	0.062		-0.074	0.086	
				Effect	*SE*	99% CI
Indirect effect of loneliness				-0.019	0.040	-0.129 to 0.043

Note: PDI=pain during intercourse; CI=confidence interval; all results are standardized; analyses controlled for race; ***p<.001

Sensitivity Analyses. The simple mediation analyses described above in Aim 3 were re-run to examine the mediating role of loneliness in the relationship between PDI and depressive symptoms using alternative outcome variables or among a subset of participants who had a non-zero score on the PDI variable (n = 133). Analyses controlled for race, and GAD7 and age were used as auxiliary variables.

Time 2 Depressive Symptoms instead of Change as an Outcome. Results of the mediation analysis of acute pain indicated that loneliness accounted for 10.4% of the variance in the model. More severe PDI in the past 4 weeks was associated with greater

loneliness (β = .322; 99% CI = .118 to .516), and loneliness was significantly associated with depressive symptoms at T2 (β = .543; 99% CI = .288 to .748). PDI was indirectly related to greater depressive symptoms through loneliness (standardized indirect effect = .175; 99% CI = .069 to .328) without controlling for baseline PHQ8. After accounting for loneliness, the relationship between PDI and depressive symptoms was no longer significant (standardized direct effect = .107; 99% CI =-.235 to .410). When the same analyses were running controlling for baseline PHQ8, the indirect effects were no longer significant.

Among Individuals Who Experience Pain. Similar to results for the total sample, indirect effects were significant for cross-sectional analyses at baseline for acute pain (n=133; standardized indirect effect = .164; 99% CI = .059 to .279) and lifetime pain (n=209; standardized indirect effect = .192; 99% CI = .103 to .303), but were not significant for longitudinal analyses for acute pain (standardized indirect effect = .014; 99% CI = -.092 to .195), or for lifetime pain (standardized indirect effect = -.028; 99% CI = -.140 to .065). The outcome for all of these analyses was change in depressive symptoms.

Exploratory Aim: Moderation

History of sexual abuse, relationship satisfaction (RAS), and pain catastrophizing (PCS) were run individually as exploratory moderators of the mediation described in Aim 3. As there were no *a priori* hypotheses, factors were examined moderating both the path from PDI to ULS (x→m path) and the PDI to change in PHQ8 (x→y path). For the x→y path, moderating effects were non-significant for sexual abuse (p=.439), RAS (p=.480), and PCS (p=.242). Similarly, for the x→m path, no moderating effects were significant

for sexual abuse (p=.756) and PCS (p=.365). RAS demonstrated a significant moderating effect on the x→m path (p=.032), such that among individuals who reported higher relationship satisfaction, the relationship between PDI and ULS was positive. The unstandardized simple slope for individuals in the 15th percentile (RAS=3.07) was -.28 (*p*=.680); the unstandardized simple slope for individuals in the 50th percentile (RAS=4.21) was 1.11 (*p*=.068); and the unstandardized simple slope for individuals in the 84th percentile (RAS=4.86) was 1.90 (*p*=.023). However, the conditional indirect effects were non-significant (index of moderated mediation = .010; 99% CI = -.119 to .146).

CHAPTER IV

DISCUSSION

The present study's overall objective was to examine the temporal relationships between pain during intercourse (PDI) and depressive symptoms among women, and to test for loneliness as a mediator of said relationship. Results indicated that – while PDI, loneliness, and depressive symptoms were cross-sectionally related – loneliness was not a significant mediator between baseline PDI and change in depressive symptoms at 6-month follow-up. Additionally, this study aimed to explore potential moderators (i.e., relationship satisfaction, sexual abuse history, and pain catastrophizing) that may impact these temporal relationships. Results in the current sample reveal that these factors are not significant moderators of the relationship between PDI and change in depressive symptoms over 6 months or of the relationship between PDI and loneliness.

Cross-sectional bivariate correlations from the present study suggest that PDI, loneliness, and depressive symptoms are positively related when examined at the same time point with medium-to-large effects. Further, PDI and loneliness were significantly related to depressive symptoms at 6-month follow-up with medium-to-large effects. However, when accounting for baseline depressive symptoms, these correlations were no longer significant, suggesting that baseline depressive symptoms was better than PDI or

loneliness at predicting change in depressive symptoms over 6 months. Indirect effects/mediation analyses revealed a similar phenomenon, where cross-sectional analyses demonstrated that PDI exhibited indirect effects on depressive symptoms via loneliness, but longitudinal analyses, with change in depressive symptoms over 6-months as the outcome, were non-significant. Finally, moderated mediation analyses explored potential subgroups for which these relationships might be true, but results revealed that levels of relationship satisfaction, history of sexual abuse, and pain catastrophizing had no significant impact on the potential mediating role of loneliness in the longitudinal relationship between PDI and depressive symptoms. One significant simple slope revealed that the relationship between acute PDI and loneliness was significantly moderated by relationship satisfaction, such that as PDI increased, loneliness increased, but only among individuals who reported high satisfaction with their romantic relationship.

Results of the present study are consistent with some previous findings. For example, the present study replicated the results of the previously conducted pilot study [35] which found strong indirect effects of PDI on depressive symptoms via loneliness using a cross-sectional study of college women. Various other studies have demonstrated cross-sectional correlations between PDI and depressive symptoms [12-14, 34-45]. Together, the results from the present study and previous literature suggest that PDI, loneliness, and depressive symptoms exhibit consistent moderate-to-large positive effects when examined cross-sectionally. Importantly, when analyses were conducted using prospective change in depressive symptoms, PDI and loneliness were not linked to follow-up depression and loneliness was not a mediator. A number of studies are

available that also find little to no direct relationship between experiencing PDI and developing subsequent depressive symptoms [46-49]. One theme demonstrated by these studies, and perhaps a key reason why these symptoms are so strongly related cross-sectionally, but not longitudinally, in the present study might be a "third variable" or confounder. Rosen and colleagues' daily diary study [48] demonstrated that depressive symptoms were better explained by relationship satisfaction, partner responses to pain, and partner solicitations among women with vulvodynia. There are also *cross-sectional* studies that demonstrated no relationship between PDI and depressive symptoms. Reed and colleagues [46] found that women with vulvodynia (n=31) did not significantly differ from healthy controls (n=23) on depressive symptoms. Aside from potentially being underpowered due to small sample sizes, these women were in treatment or seeking treatment for vulvodynia, which suggests that they are a small subgroup of women with PDI. Similarly, Green and colleagues [47] demonstrated no differences in psychological symptoms between women with vulvar vestibulitis and healthy controls; however, this null finding was also among a treatment-seeking sample. Landry and Bergeron [49] found no significant difference in depressive symptoms between adolescent girls who experienced pain with sex, and asymptomatic controls; however, these groups did differ on both state and trait anxiety. As the study included adolescents between the ages of 12 and 19, perhaps researchers would have seen an increase in depressive symptoms over time as painful sexual experiences continued. Further, a relatively new line of research links maladaptive emotional regulation (ER) skills in individuals with chronic pain with psychological factors like high emotionality and depressive symptoms [121]. ER is an individual's ability to regulate how they feel (i.e. emotional state) and how they behave

(i.e. emotional expression), and poor ER skills are related to pain severity and depressive symptoms in chronic pain patients [122], and specifically, in women with PDI-related disorders [123]. Perhaps these third variables provide an important, more nuanced understanding of the relationship between PDI and depressive symptoms.

Despite the studies that found no relationship between PDI and depressive symptoms, there are several studies that are inconsistent with these and the results of the current study that do demonstrate that women with PDI or sexual dysfunction are more likely to suffer from general psychological distress and increased depressive symptoms [15, 31-33]. These conflicting results across studies could be explained by a number of theoretical and methodological factors, including sample characteristics, follow-up duration/attrition, difficulty establishing directionality, and confounding variables. First, a key reason that previous studies have found a significant association between PDI and depressive symptoms may be that they were conducted in samples of women with a clinical diagnosis of PDI [31], sexual dysfunction [15], or another diagnosis that might have a profound impact on sexual functioning such as menopause [33] or end-stage renal disease [32]. These clinical diagnoses, whether directly or indirectly related to PDI, increased severity and variability of symptoms among the women studies, which makes them better powered to detect an effect. The current study included a community-based sample with a limited range of PDI symptoms and severity, including many individuals with little-to-no PDI. Additionally, while the current sample spanned the range of possible depressive symptoms scores, most participants reported mild levels of depressive symptoms and little-to-no change in depressive symptoms on average which

could also have limited the ability to detect an effect due to restricted variability in the variables.

Second, our follow-up period was only 6-months in duration. Given that depressive symptoms exhibit trait-like characteristics (e.g., high test-retest reliability on symptoms measures; increased risk of depressive episodes after experiencing first episode) [124], it is possible that variability in depressive change scores over a 6-month time period was not optimal. In the present sample, depressive symptoms change scores were normally distributed, with modes of 0 and -1. Further, prospective correlations showed that higher T1 depressive symptoms were negatively related to change in depressive symptoms, suggesting that individuals with more severe baseline depression experienced less change in depressive symptoms over the 6-month time period. Recent research has also suggested that there might be several issues with measuring depressive symptoms longitudinally, including regression to the mean and response bias [125].

Third, even with a longer follow-up period, establishing directionality of the relationship between PDI and depressive symptoms is complex. The present community-based study measured PDI and depressive symptoms simultaneously at two time points. Previous research has shown that vulvodynia is a significant risk factor for developing a subsequent mood or anxiety disorder, and that a mood or anxiety disorder was a significant risk factor for developing vulvodynia [31]. This study included both community-based – both clinically confirmed and non-clinically confirmed – and clinic-identified women with vulvodynia, as well as controls without vulvodynia who were matched on age and ZIP code. Results revealed that women with vulvodynia were around 1.7 times more likely to develop a subsequent mood disorder and 6 times more likely to

develop both subsequent mood and anxiety disorders. Further, women with antecedent mood disorders were 3 times more likely to develop vulvodynia, 5 times more likely if they reported both antecedent mood and anxiety disorders [31]. The current study was conducted in a community-based sample without clinical confirmation of disorders or symptoms. Further, chronology of symptoms was not accurately assessed due to online survey constraints, and, thus, it is possible that some participants experienced depressive symptoms before experiencing PDI, and some participants experienced PDI before experiencing depressive symptoms. Given this, it may be questionable to use PDI as a true predictor in the present analyses. Relatedly, our measure of loneliness was measured at the same time as PDI, which further obscures our ability to examine it as true mediator.

There was a significant amount of attrition in the present study (55.5%), which might have impacted the results. Table 2 displays the baseline differences between completers and non-completers. Notably, these groups differed on the following: age, previous diagnosis of anxiety, and desire for, arousal during, and satisfaction with sexual intercourse in the past 4 weeks with study completers being older and more likely to have a diagnosed anxiety disorder at baseline. Further, in the baseline survey they reported significantly less desire for sexual activity, less arousal during sexual activity, and less satisfaction with their sex lives. These differences likely have implications for their T1 loneliness and the general lack of change in depressive symptoms over time, as research indicates that individuals who engage in less frequent and less satisfactory sexual activities are more likely to experience psychological distress or report a mood disorder [6, 7, 9-11].

Finally, relationship satisfaction is typically thought to be a protective factor in the relationship between sexual dysfunction and psychological distress [48]; however the present results indicated that PDI and loneliness were strongly related only among individuals with higher relationship satisfaction. To my knowledge there are no studies to support these findings. With the low sample size in the moderated mediation analyses and weak *p*-value (.02), it is likely that these results are spurious and non-meaningful. Future studies should further investigate the impact that romantic relationship satisfaction has on the relationship between PDI and loneliness.

Implications

Results of the present study have several important implications for future clinical practice, as well as future investigations. As previously stated, the current study has several methodological weaknesses, including attrition, sample selection, and other factors that should be addressed in future studies. However, if future investigations do confirm that loneliness does not play a mediational role in the relationship between PDI and depressive symptoms, then clinicians should work to bolster existing treatments aimed at reducing emotional reactivity to painful experiences by identifying other potential mediators and treatment targets. Research shows that cognitive behavioral therapy (CBT) is the standard treatment for individuals with chronic pain conditions [126], including conditions that cause PDI [99, 127-132].

If future, more rigorously designed investigations find that loneliness does in fact explain the relationship between PDI and depressive symptoms, then future interventions could be tailored to treat participants' feelings of loneliness. In a pilot study, an 8-week internet-based cognitive behavior therapy for loneliness demonstrated promising

reductions in participant loneliness compared to waitlist control [133]. Modules aimed to increase objective number of social interactions as well as increase quality of current social interactions by reducing social avoidance, challenging maladaptive expectations and interpretations, as well as reducing rumination about interactions with others [133], which align with Loneliness theory [86]. Indeed, most interventions to reduce loneliness include some form of social cognitive training and/or a support group [134]. Some of the above-described negative social cognitions and interactions might be the result of a deficit in social skills [135, 136]. That is to say that perhaps individuals are accurately interpreting certain negative interactions with others. In this case, social skills training might facilitate a reduction in loneliness. Additionally, smart phone-based mindfulness training has also shown significant reductions in loneliness and increases in objective social interactions among adults [137].

Further, treatments targeting emotion regulation in both partners might show promising effects among women with PDI. One study in women with PVD and their partners demonstrated that when both partners were low on ambivalent emotional expression, they reported higher satisfaction and higher sexual functioning [123]. Thus, treatments focused on regulating emotions and communicating emotions effectively among both partners in a relationship might decrease loneliness and, in turn, depressive symptoms among women with PDI. In a randomized clinical trial among individuals with multiple somatoform symptoms comparing the CBT and CBT with ER training (CBT-ER), researchers found that CBT-ER had trending superiority over CBT in reducing severity and symptom count [122].

Limitations and Future Directions

As suggested above, several limitations of the current study should be considered with suggestions for future investigations. First, there were some methodological and measurement errors. The mediator was measured at the same time point (T1) as the predictor. In order to test a true mediation, the mediator should have been measured at time point in the middle of the predictor and outcome. Future studies should measure each of these key variables on at least three different occasions and utilize mixed model analyses to ascertain how change in variables are related to change in other variables over time. Further, the one follow-up survey after a 6-month period between T1 and T2 was likely too short to detect a meaningful change in depressive symptoms, especially with the goal of detecting change in depressive symptoms as a result of PDI. Future multi-year studies should have additional follow-up surveys at 5-month intervals to account for the episodic nature of depressive symptoms, and to avoid measuring these variables at the same time of year each year.

The study also had a significant attrition rate, particularly among the SONA (undergraduate) sample. T1 was collected during the semester and was included as a course requirement for intro psychology students, but T2 was collected after course enrollment was concluded, and thus, could not be required for course credit. Further, T2 data collection occurred during the summer when undergraduate students might have been off-campus and not checking their school email addresses. Future studies using college student samples should time data collection to align with semester due date and avoid collection follow-up data over the summer altogether.

Next, cross-sectional associations were detected between key variables, however, when accounting for baseline, the correlations between T2 depressive symptoms, PDI, and loneliness were no longer significant. This suggests that baseline depressive symptoms were a much stronger predictor of T2 depressive symptoms than were PDI or loneliness at T1. This is likely the reason that baseline mediation analyses (i.e. replication of the pilot study) yielded significant results, but longitudinal analyses were non-significant.

Another limitation is the general sample. Analyses like these might be better suited for a clinical sample. In other words, the associations might be better tested among women diagnosed with GPPD, PVD, or another disorder causing genital PDI. With this general sample, it is more difficult to detect which symptom (PDI or depressive symptoms) came first. Especially, given that there is a bi-directional relationship between these phenomena, in a general sample, it is difficult to elucidate the symptoms timeline. In other words, it is quite possible that there was a mix of woman who experienced depressive symptoms as a result of their PDI, women who experience PDI as a result of their depressive symptoms, and women who experience both PDI and depressive symptoms that are the result of a third variable. Future studies should recruit women with new PDI-related diagnoses to measure the change in their depressive symptoms more accurately as a result of this diagnosis. However, research in clinical samples is complex and imperfect. Studies suggests that only about 40% of women with PDI will seek treatment and, among those who do seek treatment, many wait for a significant period of time before seeking treatment [42, 84]. This could mean that they might have been

suffering with PDI and, therefore, increased depressive symptoms for several years before the first date of data collection.

The present study used race as a covariate, which is a relic of a white supremacist research practice. Generally speaking, people of different races report significantly different outcomes on a variety of measures, especially in the field of psychology. However, these differences are the result of racism and racist structures – and *not* the result of an individual's race [138]. Future studies investigating impacts of loneliness, PDI, and depressive symptoms should measure not only important demographic and healthcare factors important to health disparities – including healthcare utilization (e.g. "How often have you visited your primary care provider in the last year?") and satisfaction with care (e.g. "Were your healthcare needs met?") – but also factors that can impact psychological distress like experiences of racial, sexual, or intersectional discrimination.

Finally, alternative analyses might be implicated. For instance, future studies could investigate loneliness as a moderator of the relationship between PDI and depressive symptoms – rather than a mediator. In other words, change in depressive symptoms might be impacted by baseline feelings of loneliness, rather than *explained* by loneliness.

Conclusions

The present 6-month, longitudinal study aimed to examine loneliness as mediator of the temporal relationship between pain during intercourse (PDI) and depressive symptoms among females. Results indicated that loneliness did not mediate the temporal relationship between PDI and depressive symptoms across this time period. Potential

moderators (i.e., relationship satisfaction, sexual abuse history, and pain catastrophizing) of this relationship were explored, and results revealed that these factors are not significant moderators of the relationship between PDI and change in depressive symptoms via loneliness. This study advances the literature by expanding upon the findings from previous work on the PDI-loneliness-depression relationship, including a 2018 cross-sectional pilot study [35]. The current investigation used a longitudinal design (over six months) to provide a stronger test of loneliness as a mechanism in the relationship between PDI and depressive symptoms. Methodological weaknesses of the current study suggest that additional investigations are still needed in order to fully clarify the relationships between PDI, loneliness, and depressive symptoms. Specific recommendations (e.g., use of clinical samples, longer follow-up periods with three or more measurements of key variables, detailed assessment of symptom onset, and efforts to prevent attrition) were provided and will be critical next steps for the field.

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APPENDICES

APPENDIX A
EXTENDED REVIEW OF LITERATURE

Overview

Sexual behaviors, including sexual intercourse, can be important components of a romantic relationship and can have important implications for an individual's mental and physical health. Individuals in relationships who engage in consensual sexual intercourse more frequently are more emotionally and physically satisfied and tend to report higher overall quality of life [1-3]. Being satisfied with one's sex life is also related to improved quality of and satisfaction with romantic relationships, and dissatisfaction with sexual activities is related to dissatisfaction with romantic relationships [4-8], which may contribute to increased depressive symptoms [6]. Thus, women with sexual dysfunction, or difficulties in one or more area of sexual function, tend to report less life and relationship satisfaction and greater psychological distress [9-11], specifically greater depressive symptoms [12-15]. The current project examined one area of sexual dysfunction, genital pain or discomfort during intercourse, as a critical factor that may be prospectively associated with heightened depressive symptoms among adult women, and also examined mediators and moderators of this relationship.

To begin, prevalence data and definitions are presented for sexual dysfunction and relevant sexual disorders, particularly those related to genital pain. Next, background information on how sexual pain at both clinical and subclinical levels might interfere with individuals' psychological functioning are discussed. In particular, previous research links both genital pain and loneliness to depressive symptoms, so these relationships are examined in detail. Although research related to the direct connection between genital pain and loneliness is quite sparse, empirical evidence suggests that these variables might be related. Such information was used to justify the present study, in which the following mediation model was tested: loneliness as a pathway by which more severe and interfering genital pain during intercourse (PDI) contributes to greater depressive symptoms among women. Evidence was then be presented for the potential moderators (i.e. that relationship satisfaction, sexual abuse, and pain catastrophizing). These three variables served as potential moderators of the primary mediation analysis.

Pain during Intercourse (PDI): Statement of the Problem

Definitions and Prevalence. Female sexual function encompasses several domains, including interest in sex, arousal, lubrication, orgasm, satisfaction, and genital comfort. Sexual dysfunction describes significant difficulties with one or more of those areas, and affects 14 to 53% of women [16-20]. Further, around 40 to 50% of women endorse at least one symptom of sexual dysfunction in their lifetime [21]. PDI and sexual dysfunction are found at similar rates in infertile women and healthy controls [139].

Genital discomfort or PDI is one aspect of sexual dysfunction, affecting between 6.5 and 45% of older women and 14 and 34% of younger women [22-24]. Genital PDI can include pain in the following areas: The vulva and vulvar vestibule, as well as muscular areas like the pelvic floor, or vaginal muscles. Some evidence suggests that sexual dysfunction is related lower

frequency and/or poorer quality of sexual intercourse, which can lead to increased negative mood [25, 26]. However, other studies suggest that PDI and sexual satisfaction might be unrelated [27], meaning that the sex lives of women who experience PDI are not impaired by pain, but by other factors, including anxiety and avoidance of sex [27]. Further research should explore the different factors that influence these phenomena.

Chronic Vulvovaginal Pain Syndromes. Women who experience PDI can also experience genital pain during other activities, like inserting a tampon [23, 31, 49, 140]. Within pain literature, pain disorders are defined by the location of the pain and not by interference with activities. Thus, Binik [140] argued that genital PDI should be classified as a pain disorder, rather than a psychological disorder. Indeed, one cross-sectional study examined biopsychosocial outcomes in women who experience vestibular PDI and women with non-genital postherpetic neuralgia (PHN), a pain disorder that can occur as a result of the shingles infection, and found that groups did not differ in pain catastrophizing, pain anxiety, stress, depression, anxiety, sleep disturbance, or relationship adjustment [41]. These findings offer evidence that genital pain disorders are similar to other chronic pain disorders in psychological outcomes and should be studied among them. In the following section, definitions and prevalence for specific common chronic vulvovaginal pain syndromes are described.

Vulvodynia and Provoked Vestibulodynia. Vulvodynia is chronic pain of the vulva with no known cause (i.e., not caused by an infection or skin condition), which affects around 7-8% of women of reproductive age [141-143]. Provoked vestibulodynia (PVD; formerly vulvar vestibulitis syndrome) is believed to be the most common type of vulvodynia [144]. It is described as acute pain on the vulvar vestibule when the area is touched, including during sexual intercourse [145, 146]. PVD is diagnosed after a physical examination in which a gynecologist

applies light touch to the vestibule using a cotton swab and the woman's pain is assessed [145, 147]. There are two types of PVD, primary (PVD1) and secondary (PVD2). Women with PVD1 report pain during their first attempts at intercourse, while women with PVD2 report experiencing a period of pain-free intercourse [148]. Some evidence suggests that women diagnosed with PVD1 and PVD2 have different biological and psychological outcomes [148, 149]. In fact, studies have found that women with PVD1 reported higher pain severity, trait anxiety, and dysmenorrhea (or menstrual cramps), as well as childhood enuresis, family history of PDI, and lower resting blood pressure compared to women with PVD2 [145, 148, 150, 151]. Other studies have found differences in the location of pain, the size of the pain location, and the severity of the pain [152, 153]. Additional biological investigations have shown that women with PVD1 showed significantly increased levels of progesterone compared to women with PVD2 [154]. Further, studies have found that women with PVD1 have an increased amount of nerve endings in tender vestibular areas when compared with PVD2 and control patients [155]. Women with PVD2 have shown increased lymphocytes (or white blood cells within the lymphatic system) compared to women with PVD1 and controls [155]. Other studies have found no significant or meaningful differences between women with PVD1 and PVD2 [156-158].

Provoked vestibulodynia can be a pervasive disorder with women reporting symptoms for up to 10 years [159]. However, one longitudinal study [160] revealed that women with PVD showed clinically significant reductions in pain at 2-year follow-up, regardless of whether or not they received treatment.

Pelvic Floor Hypertonicity. Another disorder that is commonly linked with PVD is pelvic floor hypertonicity (PFH), a dysfunction in the pelvic floor muscles (PFM), which causes pelvic floor muscles to be tightened, or flexed, and unable to relax, which can cause pain during

vaginal penetration or make penetration impossible [161, 162]. There is some evidence to suggest that tightening of the pelvic floor muscles is a natural bodily reaction to vestibular pain, which after repeated exposure, can cause dysfunction in these muscles [131, 163-167]. There is also evidence to suggest that PFH causes changes in the way sensory information is perceived in the vestibule, such that an individual feels pain when light pressure is applied [168]. Some studies have found significant differences in pelvic floor functioning between women with PVD and pain-free controls [166, 167], while others have found no differences [164, 169].

As alluded to previously, some theories suggest that vaginal tensing is a protective behavior in reaction to vulvar or vestibular pain. Specifically, the circular cognitive behavioral model of provoked vestibulodynia [131, 170] states that cognitive-emotional processes such as catastrophizing, fear of pain, pain anxiety, and pain anticipation can lead to such physical reactions in the pelvic floor. In fact, research demonstrates that maladaptive cognitions about pain, particularly pain catastrophizing, is related to increased pain in women with provoked vestibulodynia [98]. This model suggests that vestibular PDI can lead to these psychological anxiety/fear processes, which can then lead to vaginal tensing, avoidance of intercourse, and eventual pelvic floor dysfunction. This model is depicted in Figure 1A.

Other Conditions Related to Painful Intercourse. Other disorders or conditions that are not directly related to genital pain but are often associated with painful intercourse include: endometriosis, chronic pelvic pain (CPP), and sexually transmitted infections (STIs). Endometriosis is a disorder affecting 6-10% of women [171] in which the inner lining of the uterus grows outside the uterus. CPP is pain in the lower abdomen or pelvis and affects between 2.1 and 24% of women worldwide [172, 173]. CPP can cause pain with a variety of activities, including sexual activities, bowel movements, and urination [173, 174]. Certain STIs (e.g.,

chlamydia, condylomas, and genital herpes) can also cause PDI in women [175]. Given that the present study assessed non-clinical pain experienced during intercourse (i.e. women without a pain diagnosis), women with endometriosis, CPP, and STIs were still be eligible to participate in the study. However, these diagnoses were collected and considered for control variables for final analyses.

Clinical Sexual Dysfunction. There are four categories of sexual disorders in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM), including disorders on desire, arousal, orgasm, and pain. When a woman's sexual pain reaches severe and psychologically distressing levels, she may meet criteria for a sexual pain disorder. The *DSM-IV-TR* described two female sexual disorders involving genital pain: Dyspareunia and Vaginismus. Dyspareunia described vulvovaginal pain (i.e. pain in the vagina and/or the surrounding area) caused by penetrative intercourse. Vaginismus described genital tightness caused by muscle spasms which interfered with or impeded penetration during intercourse [28], but pain was often reported by women with vaginismus [29]. For this reason, the *DSM-5,* revised these two disorders by merging them into one: Genito-pelvic Pain/Penetration Disorder (GPPD). GPPD requires the following criteria: persistent or recurrent difficulties that result in significant distress with one or more of the following for at least 6 months: 1. Genital penetration during intercourse; 2. Marked vulvovaginal or pelvic pain during vaginal intercourse or penetration attempts; 3. Marked fear or anxiety about vulvovaginal or pelvic pain in anticipation of, during, or as a result of vaginal penetration; and 4. Marked tensing or tightening of the pelvic floor muscles during attempted vaginal penetration [30]. These *DSM-5* changes were not particularly controversial, given that there is little evidence for the existence of vaginal muscle spasms that were thought to cause vaginismus [140]. Further, as pain is typically involved in both diagnoses, it was nearly

impossible to reliably differentiate between a diagnosis of vaginismus and dyspareunia within clinical practice or research [176]. The above-mentioned circular model for women with PDI argues that vaginal tensing is a protective behavior in response to vulvar pain during intercourse [131, 170], suggesting that vaginismus is often the result of dyspareunia.

An important addition to the *DSM-5*, neglected by the *DSM-IV-TR,* is the requirement for significant distress in relation to vaginal penetration. This addition is important, because it highlights the psychosocial and relational components of genital pain experienced during sexual intercourse. One *DSM-IV-TR* requirement dropped by the *DSM*-5 was the interference with sexual intercourse [28, 30]. Many things in life can interfere with sexual intercourse (e.g., busy schedules, headaches etc.), which are not considered sexual disorders. Further, research suggests that, despite experiencing pain, many women do not avoid sexual intercourse and many do not discontinue intercourse due to pain [78, 177]. These findings suggest that "interference with sexual intercourse," a *DSM-IV-TR* criterion, is invalid. Overall, the *DSM-5* has adopted more empirically and clinically supported diagnostic criteria that conceptualize GPPD as genital pain that interferes with a woman's psychological functioning, instead of a psychosexual disorder that results in genital pain [178].

Summary. Given the revised titles in sexual pain diagnoses over time, the variety of possible diagnoses/conditions that can include PDI, and that the current study is not collecting data in a specific clinical diagnostic sample, the present document uses the broad term – pain during intercourse (PDI) – to discuss all above-mentioned disorders related to bodily pain that can be caused by vaginally penetrative sexual activities. This decision is to provide parsimony to the discussion of sexual pain as well as to be maximally inclusive of all potential participants experiencing pain related to their sexual functioning.

Causes & Risk Factors of PDI

The above evidence suggests that genital pain and sexual dysfunction are prevalent and that PDI can cause significant impairment. Several potential causes and risk factors for these conditions are discussed below.

Sexual and Physical Abuse. Evidence suggests that women with a history of physical and/or sexual abuse tend to experience higher rates of sexual dysfunction, including sexual pain disorders [39, 94, 95]. Indeed, one study found that young adult rape victims were more likely to experience pelvic floor and sexual dysfunction, including pain and lubrication issues [93]. One large study of 1,425 high school girls aged 12 to 19 revealed significant differences in sexual abuse history between PDI and pain-free girls [49]. However, there is some contrasting evidence to suggest that there is no relationship between childhood sexual abuse and vulvodynia [179].

Psychological Factors. Previous research suggests that psychological disorders, like depression and anxiety, are common risk factors for chronic pain disorders [180]. Further, a variety of factors increase pain intensity in women who experience PDI, including somatic hypervigilance, pain catastrophizing, fear of pain, negative attitudes about sexuality, distraction from sexual cues, anxious symptoms, negative causal attributions for pain, low self-efficacy in coping with pain, and depressive symptoms [39]. Indeed, there is no solid evidence that these factors directly *cause* PDI, but they are considered among etiological risk factors.

Medical Factors. In one study, 57% of women reported various health events that preceded the onset of their PDI (i.e., PVD2), including the birth of a child (22%), laser treatment for human papilloma virus (HPV) (17%), an episode of complicated cystitis (i.e., inflammation or infection of the urinary tract) (11%), a severe or recurrent episode of vaginitis (i.e., inflammation or infection of the vagina or vulva) (4%), and a flare up of irritable bowel

syndrome (i.e., a chronic gastrointestinal disorder) (2%) [154]. One large study found that having children, being of average-to-poor health, and having a previous abortion were all risk factors for PDI [181]. Further, research shows that women with vulvar vestibulitis were significantly more likely to report a history of recurrent yeast infections [182], and bacterial vaginosis [183, 184]. Furthermore, the above-mentioned study among school-age girls by Landry and Bergeron [49] indicated that girls who experience PDI were more likely to report engaging in potentially harmful vaginal hygiene practices (e.g. washing with perfumed soap, shaving pubic hair, wearing pads while not menstruating etc.), all of which can lead to vaginitis [185]. Women with comorbid pain conditions are more likely to report PDI than healthy controls [186]. Evidence also suggests that women with non-alcoholic fatty liver disease might be at higher risk for female sexual dysfunction [187].

Consequences of PDI

The above evidence suggests that PDI, other sexual pain, and/or genital pain disorders have several potential causes and risk factors. Several psychosocial outcomes for these conditions are discussed below.

PDI and Health Implications. Compared with healthy women, women with chronic pelvic pain reported significantly poorer general health. Further, women with endometriosis report high rates of health distress, pain with intercourse, and impairment in their daily activities [172]. Women with PDI report significantly greater pain catastrophizing, depression, anxiety, sleep disturbances, and sexual functioning than pain-free controls [41].

PDI and Depression. Women who experience painful sexual intercourse regardless of whether they have sought or received a diagnosis, are more likely to suffer from general psychological distress, and, in particular, increased depressive symptoms [15, 31-33], which

serves as the primary outcome variable for this thesis. A number of additional cross-sectional studies reveal that genital PDI was related to increased depressive symptoms [12-14, 34-45]. A number of studies are also available that find little to no direct relationship between painful intercourse, and/or vaginal/vulvar complaints and depressive symptoms [46-49, 182, 188]. Details of these studies can be found in Table A1, and their findings can be found in Table A2.

In longitudinal studies, PDI has been shown to predict increases in depression or depressive symptoms [50]. However, the directionality remains unclear, as there is often conflicting evidence. For instance, Khandker and colleagues [31] found that vulvodynia increases the risk of new and recurrent onset of a mood disorder but also found that a diagnosed depressive disorder (DSM-IV) was an independent predictor for developing vulvodynia. These findings highlight the possibility of a bidirectional temporal relationship between PDI and depressive symptoms. Although the relationship between PDI and depressive symptoms has been previously documented, the directionality and potential mechanisms of this relationship have yet to be clarified. Identifying the mechanisms, moderators, and directionality of the PDI-depression relationship is important because this could provide us with potential targets for intervention. Clarifying mechanisms of this relationship will help researchers and clinicians to determine for whom depression might cause sexual dysfunction or PDI, and for whom PDI might cause depression.

Potential Mechanisms of the PDI-Depression Relationship

Previous research suggests that partner responses to genital PDI can influence women's depressive symptoms [51]. Comorbid pain conditions can also increase depressive symptoms in women with PVD [186]. In addition to these factors, research suggests that loneliness might be

an important factor in the context of chronic genital PDI in women, as such loneliness is the primary mechanism of focus for this thesis.

Definition and Theories of Loneliness. Loneliness, or the perceived lack of social connectedness, has important psychological and physical health implications. Loneliness researchers argue that social isolation and loneliness are separate constructs. Social isolation is an objective indicator of a lack of social connections, while loneliness is a subjective experience, the dissonance between an individual's current perceived and preferred state of social connectedness [52]. Having fewer social connections does not tend to strongly correlate with self-reported loneliness [53], suggesting that fewer social connections, or friends, does not make individuals more lonely. The current study adopted the most widely accepted definition of loneliness, the *subjective* rather than *objective* lack of social support and connectedness [54]. Perceived social isolation predicts a variety of health complications, including all-cause mortality [55, 56], reductions in physical activity [57], and increased blood pressure [58].

Loneliness theory describes a pattern of cognitions and behaviors that can increase and maintain loneliness. Lonelier people tend to have more negative social cognitions or negative expectations of others, which can then lead to more negative interactions with others, and these interactions can maintain negative social cognitions [86]. Further, social connectedness, or the quality of one's social support, also plays a role in increased loneliness and negative social cognitions [86]. Evolutionarily, lonely individuals feel less safe than those who are not lonely, which can increase their sensitivity to threats and increase self-protective behaviors, such as taking steps to prevent rejection [87]. These behaviors serve to maintain these damaging interactions with others, and thus, perpetuate a cycle [87]. Given that sex is typically a taboo subject in American society, it is possible that women with sexual dysfunction or PDI are not

getting the social support that they need, creating a dissonance in their desired social support and their actual social support. Importantly, the cycle of loneliness may also contribute to the aforementioned relationship between PDI and depression. Thus, literature linking loneliness to female genital pain and depressive symptoms are discussed below.

Loneliness and Depression. Loneliness has important psychological and physical health implications, and the relationship between loneliness and depression is well-established. Longitudinal studies show that loneliness predicted increases in depressive symptoms among a variety of samples, including health adults, patients with cancer, HIV, and fibromyalgia, and children, adolescents, college freshmen, and the elderly [54, 59-70]. Lonelier individuals also tend to have higher rates of sleep disturbance and engage in less physical activity, two factors that are related to increased pain and depressive symptoms [62, 63, 71-74]. Table A3 outlines the designs of these listed study, and Table A4 outlines how these variables were measured and their findings.

The Missing Link: Pain during Intercourse and Loneliness

Although women who experience PDI and/or loneliness are more likely to experience depressive symptoms, the relationship between PDI and loneliness remains unclear. Currently, only one study has examined the relationship between PDI and loneliness. Stout and colleagues [35] found a positive cross-sectional correlation between PDI and loneliness, and further suggested that loneliness may mediate the relationship between PDI and depressive symptoms. The present study aims to expand these findings using longitudinal data to elucidate the temporal relationships between these variables.

Despite the lack of explicit examination of loneliness in relation to PDI, previous research also suggests a theoretical link between PDI and loneliness. In a qualitative study by

Connor and colleagues among women dealing with vulvar pain and their male partners, a common theme that emerged was women feeling socially isolated and less connected [76]. Even though this study used the term social isolation, they defined it as social connectedness, suggesting that this variable was more closely related to loneliness than social isolation. As previously stated, in loneliness research, social isolation is objective social connections (i.e. number of friends), while loneliness is subjective feelings of connectedness (i.e. the quality of one's friendships) [52]. There are several factors that might explain why women who experience PDI might also report greater loneliness. Some of these have been synthesized into theoretical models (discussed below) that help guide the discussion of the relationship between PDI and loneliness.

Communal Coping Model of Pain. One theory that might explain these relationships is the Communal Coping Model of Pain [77]. This theory emphasizes the importance of communicating pain-related distress to important others to receive needed or desired support and care. Research suggests that communication around sexual dysfunction and PDI is difficult for women for a variety of reasons, and these reasons are explored below.

Communicating Pain with Sexual and Romantic Partners. In a study among women who reported PDI, Elmertstig and colleagues [78] revealed that around 47% of women reported continuing intercourse despite pain, 22% reported feigning enjoyment, and 33% reported not telling their sexual partner about their pain. Another study found that 36% of women consistently persisted through PDI, and 5% reported that they tolerated PDI some of the time [79]. A qualitative study, Elmerstig and colleagues [81], suggested that young women might conceal their PDI from their partners in order to feel normal. Similarly, another study [80] identified a variety of relationship-related themes from interviews with women with GPPD, including failure

as a sex partner, girlfriend, and person; and a fear of being abandoned. Women in this study [81] reported feelings of resignation, sacrifice, and guilt when asked about why they persist through PDI. These studies highlight that women commonly report not only persisting through PDI, but also take steps to hide their PDI from their sexual or romantic partners.

Another reason that women might hide their PDI from their partners might be a fear of their partners' reactions. One study [79] that examined the reasons why women persist through PDI demonstrated that women with PDI reported fear avoidance, task persistence, and mate guarding motivations. This suggests that women continued to have sexual intercourse despite pain because they feared their partners' reactions, to simply avoid their reactions, and/or to protect their partner from their pain. Similarly, Awada and colleagues [123] revealed that women with PVD and male partners who reported lower emotional ambivalence reported not only higher dyadic adjustment but higher sexual satisfaction, higher function, and lower depression scores. Further investigations have demonstrated that women with partners who offered more facilitative responses to pain reported higher relationship and sexual satisfaction [27, 89, 189-193]. Additionally, compared to women who reported lower sexual communication, women who reported higher communication also reported higher sexual function and satisfaction, as well as an increase in positive pain-related thoughts and a decrease in pain intensity during intercourse [194]. These findings suggest that the reactions or perceived reactions from sexual or romantic partners play an important role in the psychosocial and sexual outcomes in women who experience PDI, including their experience of loneliness.

Communicating Pain with Close Friends. In addition to difficulties discussing pain with their partners, women who experience PDI may also feel discomfort sharing their experiences with PDI with their close friends or acquaintances. One qualitative study by Svedhem and

colleagues [80] found that loneliness was a major theme to emerge from the interviews with women diagnosed with vaginismus. Women in the study reported they had no one to talk to, they felt excluded, and they felt forced to lie about their condition [80]. Further, in a large survey of 1,847 women who sought information from the National Vulvodynia Association, approximately 42% reported feelings of isolation, invalidation, or both [82]. These findings highlight that the lack of communication about PDI not only with romantic partners, but with close friends and acquaintances. This lack of communication can results in unmet social needs, or loneliness.

Communicating Pain with Physicians. Women also report discomfort related to discussing their sexual functioning with physicians [83]. One study by Berman and colleagues [84] found that 40% of women did not seek treatment for their sexual issues, with 54% of those women reporting that they wanted to. An additional study found that 39% of women with vulvodynia symptoms did not seek treatment [42]. Adegunloye and Ezeoke [85] found that a majority of sampled patients never sought medical help for their sexual dysfunction, and 26% explained that fear of stigma was the reason. This fear of stigma might lead to loneliness in women with PDI. In fact, loneliness is common among stigmatized populations, including individuals with psychological disorders and HIV, and loneliness has also been shown to be positively related to depressive symptoms in these populations [12, 60, 195-197].

Women reported that they will not discuss these issues with their physician unless their physician specifically asks about them [198]. This is an important issue, because physicians do not regularly assess patients' sexual functioning. Indeed, while 90% of physicians in one study reported that sexual issues should be addressed, 94% were unlikely to directly ask their patients about their sexual functioning [199]. Importantly, only 40% of obstetricians and gynecologists

routinely assess patients' sexual functioning [200]. Furthermore, only 57% of physicians reported feeling comfortable facilitating these conversations about sexual functioning [199].

These findings highlight a lack of comfort from both patients and physicians with discussing sexual function and dysfunction. This lack of comfort in physicians might be a result insufficient training. In fact, medical training in issues of sexuality generally focuses on preventing pregnancy and sexually transmitted infections [201]. In a large survey of over 2,000 medical students, more than 50% felt they had not received adequate training on human sexuality [202]. Additional medical training in human sexuality, particularly communication skills focused on increasing comfort with facilitating conversations about sexual functioning, could increase the amount of women receiving needed treatment for PDI or other sexual dysfunctions. In fact, of physicians who underwent additional training in human sexuality, 53% reported improvements in their knowledge and abilities to treat sexual dysfunction [199].

Other Supportive Theories. Drawing from Loneliness Theory [86], women who experience PDI might think that their partners, friends, or physicians might react in a negative way or might judge them if they bring up their pain (negative social cognitions/expectations). These negative cognitions might affect the way they act around these important others in their lives, and in turn maintain the negative cognitive cycle.

Summary. Women with PDI and PDI-related disorders often report difficulty discussing their PDI with their partners, friends, and physicians. Drawing from the Communal Coping Model, these difficulties with communication highlight an important deficit in social support. Women who are struggling to communicate their pain to important people in their lives may not be receiving adequate support and, thus, may experience increased feelings of loneliness [127].

Potential Moderators

The Potential Role of Relationship Satisfaction. Relationship satisfaction plays an important role in the relationship between PDI and depressive symptoms. Research links relationship dissatisfaction with depressive symptoms in women with PDI [88-91]. Further, relationship satisfaction is significantly related to sexual satisfaction [7, 8, 91, 92], and a variety of studies link sexual dissatisfaction with depressive symptoms [6, 88]. In fact, in a study of 63 women with CPP, pelvic pain was significantly positively related to depressive symptoms, and relationship quality with their partners was significantly negative related to depressive symptoms [203]. Additionally, loneliness has been linked to relationship dissatisfaction among college students and among a general sample [204, 205]. These findings suggest that relationship satisfaction might act as a "buffer" between PDI and psychological symptoms. For instance, those with high relationship satisfaction might experience lower levels of psychological symptoms, or none at all. Similarly, those with low relationship satisfaction might not have this "buffer," and therefore they might experience greater psychological symptoms.

The Potential Role of Sexual Abuse. As previously mentioned in this document, evidence demonstrates that sexual abuse is a risk factor for sexual dysfunction and PDI [39, 49, 93-95]. Additionally, a number of studies suggest that a history of sexual abuse is related to greater depressive symptoms [206-209]. Loneliness has also been shown to be positively related to a history of sexual abuse [209, 210]. Unlike relationship satisfaction, sexual abuse might serve to enhance the relationship between PDI and psychological symptoms. For instance, those with PDI who have a history of sexual abuse might experience greater psychological symptoms, as compared to women with PDI without a history of sexual abuse.

The Potential Role of Catastrophizing. Pain catastrophizing describes pain-related cognitive processes, including three components: rumination, ("I cannot stop thinking about the pain"), magnification ("This pain is the worst"), and helplessness ("There is nothing I can do about the pain") [97]. Pain catastrophizing has been shown to be related to depressive symptoms in variety of chronic pain samples [77, 96]. Importantly, studies among women with provoked vestibulodynia (PVD) have shown that pain catastrophizing is related to increased severity of genital pain [98, 99]. Similar to sexual abuse, increased pain catastrophizing might serve to strengthen the relationship between the variables of interest in the present study.

Summary. First, evidence demonstrating the established relationships between PDI and depressive symptoms, and between loneliness and depressive symptoms were presented. Then, despite the lack of evidence for a direct link between PDI and loneliness, a rationale was provided for investigating loneliness in women with PDI. Further, evidence was given for three potential factors that might moderate these established relationships. All three moderating factors were significantly related to depressive symptoms, and two factors (sexual abuse and relationships satisfaction) were related to loneliness. However, many of these relationships have not been studied in women with PDI or PDI-related disorders. Therefore, the present study investigated these factors within the context of PDI, loneliness, and depressive symptoms.

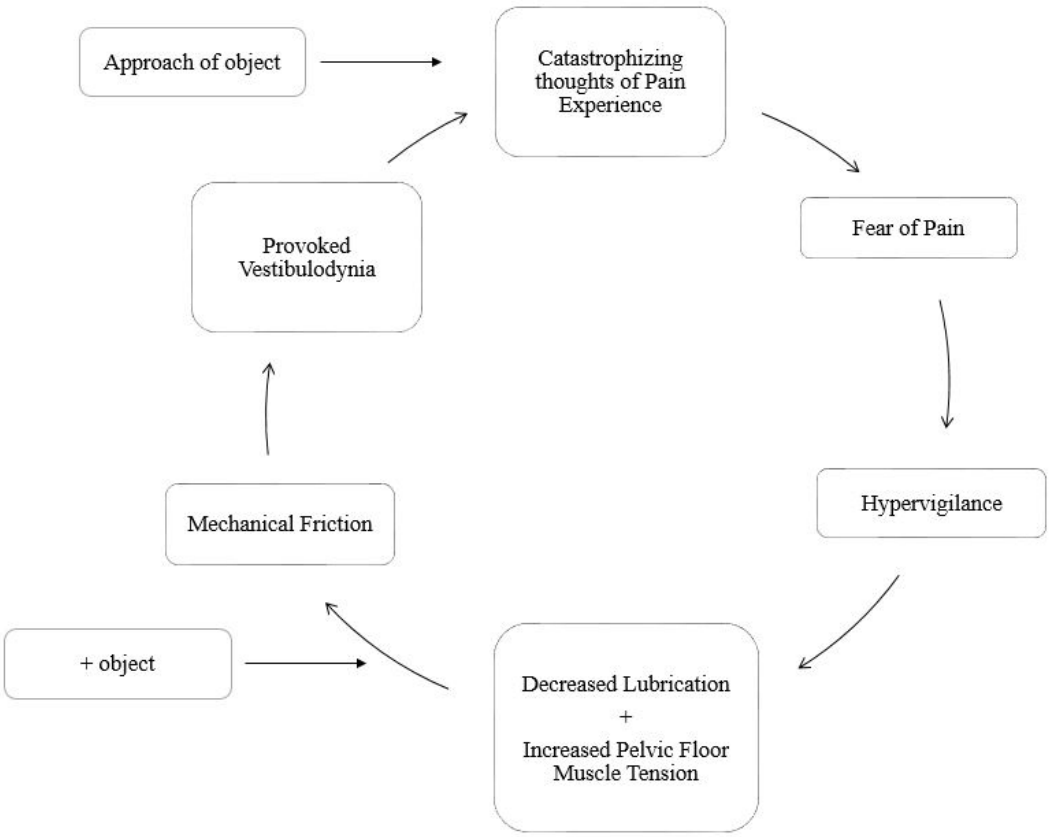

Fig. 1. Adapted from ter Kuile (2012) Circular Cognitive Behavioral Model of Provoked Vestibulodynia (PVD). "Penis" was changed from the original figure to read "object" to better reflect the variability in penetrative object during intercourse

Table A1

Characteristics of the Studies Evaluating Depressive Symptoms in women with PDI

First Author	**Sample**	**Design**
Aikens (2003)	32 women with vulvar dysesthesia (vulvodynia) 32 asymptomatic controls	cross-sectional, case-controlled questionnaire

Arnold (2007)	100 women with vulvodynia 325 asymptomatic matched controls	cross-sectional, case-control questionnaire
Boerner (2015)	61 women with PVD and their partners	cross-sectional questionnaire
Dargie (2017)	65 women with PVD 30 women with postherpetic neuralgia (PHN) 108 pain-free controls	cross-sectional questionnaire
De Graaff (2016)	83 women with endometriosis & 74 partners; 40 women with controception issues & 26 partners	cross-sectional questionnaires
Foster (1995)	95 women with vulvar vestibulitis 188 controls	case-controlled, cross-sectional questionnaire
Green (2001)	Review article	
Heinburg (2004)	22 women with chronic pelvic pain 22 men with penile or testicle pain 22 women with low back pain 22 men with low back pain	cross-sectional
Iglesias-Rios (2015)	1795 women	cross-sectional questionnaire
Jantos (1997)	50 women with vestibulitis	Cross-sectional questionnaire

Khandker (2011)	240 case-controlled pairs women with w and w/o vulvodynia	cross-sectional with temporal-related questions
Leeners (2015)	women aged 30 to 50	Prospective longitudinal
Leusink (2015)	784 women 15 to 49 years of age	retrospective analysis of all episodes from 1995 to 2008
Maille (2015)	20 women with PVD1, 19 women with PVD2, 18 controls	cross-sectional survey
Meana (1997)	105 women with dyspareunia 105 matched controls	cross-sectional survey
Oliveira (2013)	17 women with sexual dysfuntion, 37 women with low sexual functioning	cross-sectional
Pâquet (2018)	127 women with vulvodynia and 127 partners	daily surveys
Payne (2007)	20 women with vulvodynia 20 healthy controls	cross-sectional survey and pelvic exam
Reed (2000)	31 women with vulvodynia 18 women with CPP 23 controls	cross-sectional questionnaire
Rosen (2014)	127 women with vulvodynia an partners	daily surveys

Table A2

Summary of Results of Studies Measuring Depression or Depressive Symptoms in Women who Experience PDI

First Author	**Pain Measure(s)**	**Depression Measure(s)**	**Main Findings**
Aikens (2003)	McGill Pain Questionnaire Pain Disability Inventory Physical Examination	BDI	women with VD reported higher depressive symptoms than did asymptomatic controls (p=.002)
Arnold (2007)	self-report vulvodynia, based on 2000 ISSVD description	self-report medical history	women with vulvodynia were more likely than controls to report depression (OR=2.99)
Boerner (2015)	Derogatis Interview of Sexual Function - Self Report	BDI-II	pain intensity in women with PVD was positively correlated with depressive symptoms (p=.01)

Dargie (2017)	FSFI	CES-D	women with PVD reported greater depressive symptoms than controls
De Graaff (2016)	FSFI	HADS	Women with endometriosis reported significantly great depressive symptoms than did controls
Foster (1995)	Self-report history	Self-report history	women with vulvar vestibulitis and controls were eqaully as likely to have a diagnosis of depression
Green (2001)	Review article		Inconsistent findings, no convincing evidence that depressive symptoms are a result of vulvar vestibultis
Heinburg (2004)	Rating scale from 0-6	BDI, CES-D	women with CPP reported greater depressive symptoms compared to women with LBP
Iglesias-Rios (2015)	Self-reported, vulvodynia dx criteria	PHQ8	women who screened positive for depression who more likely to have current vulvodynia

Jantos (1997)	Met medical diagnosis for vestibulitis	BDI	Women tended to underreport their depression history, however a large BDI scores revealed that 91% of women were at least mildly depressed, with 49% reporting potentially serious depression
Khandker (2011)	Vulvodynia	DSM-IV dx depressive disorder	women with depression or anxiety were 4x more likely to get vulvodynia than women without. AND vulvodynia was related to new onset of depression or anxiety
Leeners (2015)	Self-report history	SCL-90	dysparuenia was strongly related to depression (p=.00)
Leusink (2015)	Medical records	Medical records	women with symptoms of PVD were significantly more likely to report a comorbid depressive disorder
Maille (2015)	FSFI Scale 0-10	BDI-II	Depression was significantly correlated with pain intensity during intercourse (p<.05), with women with PVD1 reporting significantly higher levels of depressive symptoms than women with PVD 2.
Meana (1997)	SR dypareunia	BSI	Evidence suggests that depression is linked to increased pain intensity in women with GPPD

Oliveira (2013)	FSFI	BSI, BDI	depression mediated the effect of positive-trait affect and negative trait effect on sexual functioning
Pâquet (2018)	0-10 scale	Profile of Mood States	Depression and pain were significantly correlated (p<.05)
Payne (2007)	Pelvic Exam	BDI-II	No significant difference in depressive symptoms between women with vulvar vestibulitis and healthy controls
Reed (2000)	McGill Pain Questionnaire	Brief Symptoms Inventory	Women with vulvodynia more likely to report recent or current depression than health controls
Rosen (2014)	0-10 scale	Profile of Mood States	no direct relationship (relationship satisfaction as a moderator)

Note. BDI=Beck Depression Inventory; BDI-II=Beck Depression Inventory (version 2); FSFI=Female Sexual Function Inventory; CESD=Center for Epidemiologic Studies Depression Scale; HADS= Hospital Anxiety and Depression Scale; PHQ=Patient Health Questionnaire; SCL-90=Symptom Checklist 90; SR=self-report; BSI=Brief Symptom Inventory;

Table A3

Characteristics of the Studies Evaluating the Relationship between Loneliness and Depressive Symptoms in a Variety of Samples

First Author	Sample	Design
Cacioppo (2006)	Study1: 2,628 undergraduates	cross-sectional survey, EFA
	Study 2: 229 older adults aged 50-68	in-person cross-sectional survery; replication of study 1
	Study 3: 135 undergraduates (subset from study 1)	cross-sectional survey
	Study 4: 22 undergraduates	experimental
Cacioppo (2010)	229 adults between aged 50 and 68	5-year longitudinal in-person study
Grov (2010)	914 adults living with HIV	cross-sectional survey
Hawkley (2009)	229 adults between aged 50 and 68	3-year longitunidal study
Heikkinen (2004)	131 elderly adults	10-year longitudinal study

Jaremka (2013)	200 post-treatment breast cancer survivors	cross-sectional survey
Jaremka (2014)	Study 1: 49 breat/colorectal cancer survivors 66 cancer-free controls	cross-sectional survey
	Study 2: 125 caregivers 104 non-caregiver controls	cross-sectional survey
Vanhalst (2012)	313 mid-to-late adolescents	5-year longitudinal survey
Wei (2005)	308 freshman undergraduates	longitudinal survey
Wolf (2014)	118 patients with fibromyalgia	21-day daily diary study

Table A4

Summary of Results of Studies Measuring the Relationship between Loneliness and Depressive Symptoms

First Author	Loneliness	Depression	Main Findings
Cacioppo (2006)	R-UCLA	BDI	EFA distinguished loneliness and depression as separate constructs
	R-UCLA	CESD	EFA, PAF concluded that, while loneliness and depressive symptoms significantly correlated, they are separate constructs
	R-UCLA	BDI	higher loneliness was associated with greater negative mood, and lower positive mood
	R-UCLA	BDI	Compared to controls, those in the induced-loneliness group reported significantly great negative mood, and lower positive mood
Cacioppo (2010)	R-UCLA	CESD	Loneliness was a significant predictor of depressive symptoms

Grov (2010)	UCLA 3	CESD	Participants reporting clinically significant depressive symptoms reported significantly higher loneliness
Hawkley (2009)	R-UCLA	CESD	Loneliness and depressive symptoms were significantly correlated cross-sectionally
Heikkinen (2004)	SR feelings of loneliness 4-point scale	CESD	Loneliness significantly predicted depressive symptoms among both men and women at 10-year follow-up
Jaremka (2013)	UCLA 3	CESD	Loneliness and depressive symptoms were significantly correlated
Jaremka (2014)	NYUL	CESD	Loneliness independently predicted increased depressive symptoms
	NYUL	BDI-SF	Loneliness independently predicted increased depressive symptoms
Vanhalst (2012)	LACA	EDMA	Loneliness and depressive symptoms were significantly correlated after controlling for personality variables
Wei (2005)	UCLA 3	CESD	Loneliness significantly predicted depressive symptoms among both men and women at 10-year follow-up

Wolf (2014)	1-item, *were you lonely?*	5 items from PHQ9	Change in daily loneliness ratings significantly predicted a change in depressive symptoms

Note. R-UCLA=Revised UCLA Loneliness Scale; BDI=Beck Depression Inventory; CESD=Center for Epidemiologic Studies Depression Scale; UCLA 3=UCLA Loneliness Scale (version 3); SR=self-report; NYUL=New York University Loneliness Scale; BDI-SF=Beck Depression Inventory-Short Form; LACA=Loneliness and Aloneness Scale for Children and Adolescents; EDMA= Epidemiology of Depressive Mood in Adolescents; PHQ9=Patient Health Questionnaire 9

APPENDIX B

SURVEY ITEMS

Female Sexual Function Inventory (FSFI)

1. Over the past 4 weeks, how **often** did you experience discomfort or pain during vaginal penetration?

- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

2. Over the past 4 weeks, how **often** did you experience discomfort of pain following vaginal penetration?

- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

3. Over the past 4 weeks, how would you rate your **level** (degree) of discomfort or pain during or following vaginal penetration?

- Very high
- High
- Moderate
- Low
- Very low or none at all

Female Sexual Function Inventory (adapted to include lifetime sexual function)

4. In your lifetime, how **often** did you experience discomfort or pain during vaginal penetration?

- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

5. In your lifetime, how **often** did you experience discomfort of pain following vaginal penetration?

- Almost always or always
- Most times (more than half the time)
- Sometimes (about half the time)
- A few times (less than half the time)
- Almost never or never

6. In your lifetime, how would you rate you **level** (degree) of discomfort or pain during or following vaginal penetration?

- Very high
- High
- Moderate
- Low
- Very low or none at all

PHQ8
Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all	Several days	More than half the days	Nearly every day
Little interest or pleasure in doing things	○	○	○	○
Feeling down, depressed, or hopeless	○	○	○	○
Trouble falling or staying asleep, or sleeping too much	○	○	○	○
Feeling tired or having little energy	○	○	○	○
Poor appetite or overeating	○	○	○	○
Feeling bad about yourself - or that you are a failure or have let yourself or your family down	○	○	○	○
Trouble concentrating on things, such as reading the newspaper or watching television	○	○	○	○
Moving or speaking so slowly that other people could have noticed? **or** the opposite - being so fidgety or restless that you have been moving around a lot more than usual	○	○	○	○

If you checked off any problems, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

- Not at all difficult
- Somewhat difficult
- Very difficult
- Extremely difficult

UCLA Loneliness Scale

Instructions: The following statements describe how people sometimes feel. For each statement, please indicate how often you feel the way described by writing a number in the space provided. Here is an example:

How often do you feel happy?

If you never felt happy, you would respond "never;" if you always feel happy, you would respond "always."

NEVER	RARELY	SOMETIMES	ALWAYS
1	2	3	4

1. How often do you feel that you are "in tune" with the people around you?	
2. How often do you feel that you lack companionship?	
3. How often do you feel that there is no one you can turn to?	
4. How often do you feel alone?	
5. How often do you feel part of a group of friends?	
6. How often do you feel that you have a lot in common with the people around you?	
7. How often do you feel that you are no longer close to anyone?	
8. How often do you feel that yours interests and ideas are not shared by those around you?	
9. How often do you feel outgoing and friendly?	
10. How often do you feel close to people?	
11. How often do you feel left out?	
12. How often do you feel that your relationships with others are not meaningful?	
13. How often do you feel that no one really knows you well?	
14. How often do you feel isolated from others?	
15. How often do you feel you can find companionship when you want it?	
16. How often do you feel that there are people who really understand you?	
17. How often do you feel shy?	
18. How often do you feel that people are around you but not with you?	
19. How often do you feel that there are people you can talk to?	
20. How often do you feel that there are people you can turn to?	

Pain Catastrophizing Scale

We are interested in the thoughts and feelings that you have when you are experiencing pain. Listed below are 13 statements describing different thoughts and feelings that may be associated with pain. Using the following scale, please indicate the degree to which you have these thoughts and feelings when you are experiencing pain of any kind.

	Not at all	To a slight degree	To a moderate degree	To a great degree	All the time
I worry all the time about whether the pain will end.	○	○	○	○	○
I feel I can't go on.	○	○	○	○	○
It's terrible and I think it's never going to get any better.	○	○	○	○	○
It's awful and I feel that it overwhelms me.	○	○	○	○	○
I feel I can't stand it anymore.	○	○	○	○	○
I become afraid that the pain will get worse.	○	○	○	○	○
I keep thinking of other painful events.	○	○	○	○	○
I anxiously want the pain to go away.	○	○	○	○	○
I can't seem to keep it out of my mind.	○	○	○	○	○
I keep thinking about how much it hurts.	○	○	○	○	○
I keeping thinking about how badly I want the pain to stop.	○	○	○	○	○
Respond 'not at all' to this item.	○	○	○	○	○

There's nothing I can do to reduce the intensity of the pain.	○	○	○	○	○
I wonder whether something serious may happen.	○	○	○	○	○

APPENDIX C

EXTENDED RESULTS

Cross-sectional Indirect Effects Analyses (Replication of Pilot Results)

Acute (4-week) Pain. Results of the indirect effects analysis (Figure C1) indicated that loneliness accounted for 10.7% of the variance in the model. More severe PDI in the past 4 weeks was associated with greater loneliness (β = .584; 99% CI = .422 to .718), and greater loneliness was associated with greater depressive symptoms (β = .328; 99% CI = .124 to .515). PDI was indirectly related to greater depressive symptoms through loneliness (standardized indirect effect = .191; 99% CI = .080 to .310). After accounting for loneliness, the relationship between pain during intercourse and depressive symptoms was no longer significant (standardized direct effect = .033; 95% CI =-.160 to .231).

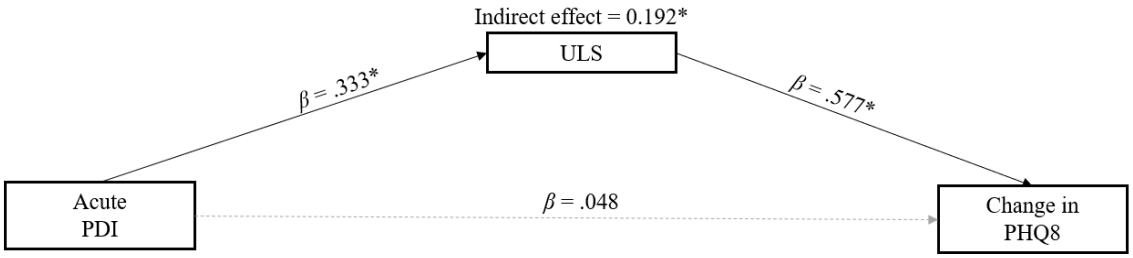

Figure C1. Standardized results of the cross-sectional mediation analysis (replication of pilot);
Notes. *99% confidence interval does not include zero; PDI=pain during intercourse; ULS=UCLA Loneliness Scale; PHQ8=Patient Health Questionnaire-8 (depressive symptoms)

Table C1. Results of Cross-Sectional Mediation Analyses

	Mediator			Dependent Variable		
	Loneliness			Depressive Symptoms		
Antecedents	β	*SE*	R^2	β	*SE*	R^2
Model 1			0.11***			0.353***
Intercept	2.161***	0.348		0.645***	0.239	
Acute PDI	0.333***	0.077		0.048	0.076	
Loneliness	-	-	-	0.577***	0.060	
Race	0.059	0.074				
				Effect	SE	99% CI
Indirect effect of loneliness				0.192	0.044	0.081 to 0.313

ADULT CONSENT FORM

OKLAHOMA STATE UNIVERSITY

PROJECT TITLE: Studying Mental And Sexual Health (SMASH) Project

PRINCIPLE INVESTIGATOR: Misty A. W. Hawkins, Ph.D., Oklahoma State University

You are being invited to participate in a research survey. This consent form will provide you with information on the research project, what you will do if you participate, and the associated risks and benefits of the research. Your participation is completely voluntary. Before taking part in this study, please read carefully the consent form below and click on the "**Yes, I agree**" button at the bottom of the page if you understand the statements and freely consent to participate.

PURPOSE:

This study is a 2-part study, including two 60-minute web-based anonymous research surveys designed to understand biological females' sexual functioning and related psychosocial factors. Survey 2 will be emailed to you 6 months after you complete part 1.

PROCEDURES

Participation in the study takes approximately 60 minutes and is strictly anonymous and voluntary. If you agree to participate, you will be asked questions about the following: 1) your demographics (examples: age, race), 2) your physical and psychological health, and 3) your thoughts, feelings, behaviors, and preferences. At the end of the survey, you will be directed to a webpage that is completely separate from your survey answers. On this new webpage, you will be asked to to enter your email address and elect whether you want us to send you the result of this survey or to contact you via email for future study opportunities. There is no penalty if you choose not to be contacted. You do not have to answer any question if you feel uncomfortable; however, you must continue to the last page of the survey in order to get to the page where you can enter your email for future contact.

COMPENSATION:

Participants will be compensated with 1 SONA research credit for completing part 1 of the study in an accurate manner. For completing part 2, participants will be entered into a drawing for a $25.00 Amazon gift card.

RISKS OF PARTICIPATION:

No deception is involved, and there are no known risks associated with this project which are greater than those ordinarily encountered in daily life. However, there is a possibility that responding to some of the questions included in this study may make you feel uncomfortable. To minimize this risk, you will not be required to respond to items that cause discomfort.

Second, participants should be aware that the survey is administered via an online survey portal, so there is a small possibility that responses could be viewed by unauthorized third parties (e.g., computer hackers). To protect against the remote possibility of loss of confidentiality, all electronic information you provide will be identified using a participant number only (your name and other identifying information will not be used). Additionally, all electronic data will be saved on password-protected computers.

Approved: 10/04/2018
Expires: 10/03/2019
Protocol #: AS-18-107

BENEFITS OF PARTICIPATION:
This research will not benefit you directly. Your participation in this study will help us to better understand more about female sexual and mental health, which will assist in improving future research, female health promotion efforts, and clinical practice. If you are interested, we will send you a copy of the results of the study when it is finished. Please enter your email and elect to have the results sent to you.

CONFIDENTIALITY:
Only members of the research team will have access to the information you provide. Should you choose to provide your email address, it will be used only for purposes of sending you notifications of study results or future study opportunities (if you elect to have us contact you in the future). Your email address will not be distributed to third parties for any reason. All electronic information you provide will be identified using a participant number only (your name and other identifying information will not be used). We may use anonymous quotations from the survey responses in our reporting of the results but these quotations will not include any information that could identify you. Additionally, all electronic data will be saved on password-protected computers.

CONTACTS:
You may contact the principal investigator of the study at the following address and phone number, should you desire to discuss the consent form, your participation in the study and/or request information about the results of the study: Misty A.W. Hawkins, Ph.D., 116 North Murray Hall, Dept. of Psychology, Oklahoma State University, Stillwater, OK 74078, (405) 744–4593, email address: misty.hawkins@okstate.edu. If you have questions about your rights as a research volunteer, you may contact the IRB Office at 223 Scott Hall, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

PARTICIPANT RIGHTS:
I understand that my participation is voluntary, that there is no penalty for refusal to participate, and that I am free to withdraw my consent and participation in this project at any time, without penalty.

CONSENT DOCUMENTATION:
I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits and risks of my participation.

If you affirm that you are 18 years of age or older, have read and fully understand this consent form, and freely and voluntarily consent to participate in the study, click on the **"Yes, I Agree"** button to give permission for your participation in this study and to begin the survey.

Approved: 10/04/2018
Expires: 10/03/2019
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COMPENSATION:

Participants will be compensated $0.50 via Amazon Mechanical Turk for completing the survey in an accurate manner. Participants will be compensated $1.00 for completing part 2 of the survey in an accurate manner.

RISKS OF PARTICIPATION:

No deception is involved, and there are no known risks associated with this project which are greater than those ordinarily encountered in daily life. However, there is a possibility that responding to some of the questions included in this study may make you feel uncomfortable. To minimize this risk, you will not be required to respond to items that cause discomfort.

Second, participants should be aware that the survey is administered via an online survey portal, so there is a small possibility that responses could be viewed by unauthorized third parties (e.g., computer hackers). To protect against the remote possibility of loss of confidentiality, all electronic information you provide will be identified using a participant number only (your name and other identifying information will not be used). Additionally, all electronic data will be saved on password-protected computers.

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CONFIDENTIALITY:
Only members of the research team will have access to the information you provide. Should you choose to provide your email address, it will be used only for purposes of sending you notifications of study results or future study opportunities (if you elect to have us contact you in the future). Your email address will not be distributed to third parties for any reason. All electronic information you provide will be identified using a participant number only (your name and other identifying information will not be used). We may use anonymous quotations from the survey responses in our reporting of the results but these quotations will not include any information that could identify you. Additionally, all electronic data will be saved on password-protected computers.

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VITA

Madison Elizabeth Stout

Candidate for the Degree of

Master of Science

Thesis: DEPRESSIVE SYMPTOMS, LONELINESS, AND OTHER PSYCHOSOCIAL FACTORS IN WOMEN WITH PAIN-RELATED SEXUAL DYSFUNCTION

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Graduate Research Assistant – Oklahoma Tobacco Research Center – Oklahoma City, OK

Research Assistant – Center for Health Sciences – Regenstrief Institute, Indiana University School of Medicine, Indianapolis, Indiana

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