Menstrual Pain Trajectories and Their Psychological and Behavioral Predictors

Hannah Marie Alves Hagy

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ABSTRACT

Despite the high prevalence of menstrual pain (i.e., dysmenorrhea) and the negative impact on quality of life, there is a dearth of research on how menstrual pain changes over time. There is also a critical need to understand psychological and behavioral predictors of these menstrual pain trajectories because dysmenorrhea is a known risk factor for the development of chronic pelvic pain (CPP) and chronic non-pelvic pain (CNPP). Given that current treatments for CPP and CNPP have had limited success, developing preventative strategies for dysmenorrhea is of high importance. Relying on longitudinal survey data collected as part of a larger investigation, the present study delineated menstrual pain trajectories over two years and examined contributions of psychological (e.g., pain catastrophizing and somatic symptoms) and behavioral (e.g., sleep) factors in predicting such pain trajectories among a sample of anatomical females ages 18-45 years of age (n= 157). Four distinct menstrual pain trajectory subgroups were identified using growth mixture modeling. A multinominal logistic regression was used to predict differences between subgroups. Only somatic symptoms were significant when predicting group membership. The study provides a deeper understanding of the complexities of heightened dysmenorrhea and suggests that somatic symptoms may be an area of focus for intervention.
CHAPTER ONE
INTRODUCTION

Dysmenorrhea presents as a unique pain condition with features of both acute and chronic pain (Low et al., 2017). Defined as cyclic menstrual pain without (primary) or with (secondary) pelvic pathology (Bernardi et al., 2017; Iacovides et al., 2015; Koninckx et al., 2017), dysmenorrhea is the most common gynecological condition, impacting 45-95% of menstruating women (Iacovides et al., 2015). Primary dysmenorrhea often occurs shortly after menses, whereas secondary dysmenorrhea may emerge later in life (e.g., second or third decade of menstruation). Secondary dysmenorrhea is most commonly associated with endometriosis, along with other pathology (e.g., fibroids, myomas). Women often believe that recurrent menstrual pain is a normal part of the menstrual cycle rather than a disorder that can be treated; thus, they do not seek out treatment. Despite the high prevalence rate, dysmenorrhea is often disregarded by both patients and medical professionals (Iacovides et al., 2015). In addition to being highly prevalent, dysmenorrhea has a negative impact on women’s well-being. In some cases, moderate-to-severe dysmenorrhea may lead to absenteeism at school or work, sleep disturbances, negative affect, anxiety, and lower physical and social activity for a few days every month (Iacovides et al., 2015; Payne et al., 2017). These consequences are not unique to Western populations, as dysmenorrhea impacts adolescent and adult women of reproductive age around the globe, making this research exceedingly important (Al-Jefout et al., 2015; Arafa et al., 2018;
Beyond the ongoing negative effect that dysmenorrhea has on quality of life, it is a risk factor for future chronic pain conditions. This association, though not completely understood, may in part be due to repeated, cyclical exposure to pain and inflammation which may lead to the amplification of certain neural pain pathways or central sensitization (Li et al., 2020; Tu et al., 2019). Though the association between dysmenorrhea and CPP/CNPP is not fully delineated, understanding how dysmenorrhea emerges over time may be essential to offsetting pain risk later in life. However, there is a scarcity of research exploring menstrual pain symptoms over time and factors that influence this. Though women often try pharmacological (e.g., non-steroidal anti-inflammatory drugs, oral contraceptives) and naturopathic (i.e., home remedies) to address symptoms, many are unable to achieve symptom relief. It is critical to identify and understand possible profiles of women with dysmenorrhea to develop effective, multimodal preventative treatment methods. The current study aimed to examine menstrual pain subgroups by investigating menstrual pain trajectories over time. Further, once menstrual pain subgroups were identified, measures of psychological and behavioral factors collected at the first timepoint were used to predict subgroup membership to better understand transitory and chronic trajectories of menstrual pain over time.

The role of psychological and behavioral factors in predicting dysmenorrhea over time can contribute to understanding the etiology as well as how to offset risks for prolonged consequences. To date, cross-sectional research identifying risk for severe dysmenorrhea has focused predominately on biological factors, such as smoking, caffeine and alcohol consumption,
younger age at menarche, extreme BMIs (low and high), heavier and longer menstrual flow, and age (Hu et al., 2020; Iacovides et al., 2015; Moghaddam Tabrizi et al., 2018; Patel et al., 2006; Tomás-Rodríguez et al., 2017). Additionally, the overproduction of uterine prostaglandins (PG) is responsible for the contraction of the uterus, which causes the painful cramping feeling experienced by women that characterizes dysmenorrhea. Because pain is an integrative phenomenon resulting from interactions between biological (e.g., uterus contraction) and contextual (e.g., psychological) processes, it is essential to conceptualize menstrual pain through an integrative framework (Allyn et al., 2020). Notably, other studies have identified social factors such as family history of dysmenorrhea, identifying with a marginalized group, and low socioeconomic status (Fernández-Martínez et al., 2018; Hu et al., 2020). However, there is a critical need to investigate dysmenorrhea drawing on an integrative framework, integrating a multitude of factors, which is rarely done (Allyn et al., 2020).

Although cross-sectional research is important in characterizing dysmenorrheic populations, it tells us very little about the causal pathways for dysmenorrhea, including how psychological and behavioral factors may contribute to chronic dysmenorrhea. To date, only a few studies have investigated menstrual pain longitudinally. Weissman et al. (2004) investigated the prevalence, course, severity, and predictive factors of dysmenorrhea by collecting survey data on 404 women (ages 19-44) with primary dysmenorrhea at two time points, six years apart. They found that prevalence rates of mild, moderate, or severe dysmenorrhea were relatively stable over time, implying that improvement and worsening of symptoms are just as likely. Nevertheless, older age and childbirth were associated with decreases in dysmenorrhea (Weissman et al., 2004). Another longitudinal study investigated dysmenorrhea across the
transition from adolescence to adulthood to consider what characteristics of menstruation during adolescence predicted dysmenorrhea severity in adulthood. For this study, adolescents treated for dysmenorrhea ($n=70$) were surveyed an average of 10.24 years later. None of the adolescent baseline factors (e.g., heavy menstrual bleeding, absenteeism, age of menarche, use of oral contraceptives, and associated menstrual symptoms) predicted dysmenorrhea severity in adulthood. Interestingly, dysmenorrhea had resolved in 25% of the sample (Knox et al., 2019). Characteristics of chronic, worsening, or even remitting groups—such as those whose dysmenorrhea resolved in the Knox et al. study—can be identified using finite mixture modeling which captures nuanced variations in the patient population. Once these subgroups are identified, characterizing the low, chronic, and improving or worsening trajectories can aid in the process of developing tailored interventions for those at heightened risk of developing chronic or worsening menstrual pain trajectories.

Although longitudinal studies have been conducted, just one study to date has allowed consideration of menstrual pain trajectories by including more than two timepoints. Drawing on the Australian women’s health study, women were recruited in early adulthood and followed for 13 years, with survey data collected at five timepoints. Relying on self-report questions of dysmenorrhea, four distinct groups emerged: normative (38.3%), recovering (17.2%), low (28%) and chronic (16.5%). Women in the chronic group were more likely to be unemployed and smoking at baseline and started smoking earlier and had an early age at menarche. The normative group was more likely to be married and to have used oral contraceptive pills. No differences between the other groups (low and recovering) were reported. This study demonstrates that dysmenorrhea had relatively stable prevalence over time, with 60% of the sample reporting
symptoms during the study period. However, this study also presented considerable variation at
the individual level, with much of the sample reporting symptoms intermittently and many
women experiencing unchanged or worsening menstrual pain over time. Although this study
provided important insight into how dysmenorrhea changes over early adulthood, the role of
psychological and behavioral factors were not investigated despite their relevance for pain
conditions more generally (Allyn et al., 2020). Examination of dysmenorrhea across adulthood
offers a critical window of opportunity to optimize and establish positive health behaviors early
on, including preventative care (Dorn & Hillman, 2009). Notably, the current study aimed to
provide valuable perspective in terms of which symptoms identified early on may predict more
stable and chronic trajectories of dysmenorrhea versus those that are remitting, potentially
informing treatments for this debilitating condition.

**Psychological Factors**

Current research supports a well-established association between menstrual pain and
various psychological factors including anxiety and depressive symptoms (Allyn et al., 2020;
Balık et al., 2014; Iacovides et al., 2015; Mou et al., 2019). However, less is known about pain
catastrophizing and somatic symptoms and the role they play in dysmenorrhea concurrently as
well as over time. In the present study, pain catastrophizing and somatic symptoms are examined
as psychological factors that may predict menstrual pain trajectory membership.

**Pain Catastrophizing**

Pain catastrophizing is defined as excessively negative orientation to noxious stimuli or a
negative mental state brought on during anticipated or actual painful experiences (Payne et al.,
2016; Sullivan et al., 1995, 2001; Walsh et al., 2003). This involves magnification and
rumination on symptoms which include feelings of helplessness (McPeak et al., 2017). Though this may be evolutionarily adaptive, such that increased awareness of pain may lead to early detection and treatment of the source of pain, research suggests that catastrophic thinking about pain likely influences the heightened intensity of pain experience (Sullivan et al., 1995, 2001). Research on women with endometriosis - a gynecological disorder where endometrium grows outside of the uterus (i.e., secondary dysmenorrhea) - has demonstrated that higher levels of pain catastrophizing, more severe dysmenorrhea, chronic pelvic pain, and abdominal wall pain were independently associated with worse quality of life after controlling for pain intensity (McPeak et al., 2017). This suggests that pain catastrophizing may influence pain health-related quality of life in women with pelvic pain disorders.

The association between pain catastrophizing and pain severity has been documented in both chronic pain and dysmenorrheic populations. In one cross-sectional study investigating a sample of adolescents with and without chronic pain conditions, a multiple linear regression analysis uncovered that only pain catastrophizing significantly predicted menstrual pain in the chronic pain group (Payne et al., 2016). Additionally, Lee et al. (2018) found that young women with primary dysmenorrhea scored higher on pain catastrophizing measures during their menstrual cycle as compared to their preovulatory phase. There was a significant difference between the healthy control ($M=23.7$ years) and primary dysmenorrhea group ($M= 23.1$ years) during both menstruation and preovulatory phase, suggesting that women with dysmenorrhea, irrespective of menstrual phase timing, engage in more pain catastrophizing than their age-and-education matched healthy control counterparts. Interestingly, research suggests that pain catastrophizing is related to menstrual pain, regardless of etiology (e.g., primary vs. secondary
dysmenorrhea) (Evans et al., 2021). Furthermore, research has suggested differences in menstrual pain severity between women who catastrophize and those that do not. One cross-sectional study of undergraduate women (ages 17-32) reported significantly worse menstrual pain in those categorized as “high catastrophizers” as compared to the “low catastrophizers” (Walsh et al., 2003). Finally, a recent qualitative study observed that adolescent and young adults with dysmenorrhea frequently engaged in catastrophizing (Allyn et al., 2020). In sum, pain catastrophizing appears to be related to menstrual pain, though this relation may be bidirectional in nature as most research in this area has predominantly relied on cross-sectional designs. The current study utilized longitudinal data in attempts to understand the impact that pain catastrophizing has on the transience or stability of dysmenorrhea over time.

**Somatic Symptoms**

Somatic symptoms are the tendency to experience one's emotions and feelings in the form of physical complaints and distress (Gelenberg, 2000) and are often described as the heightened awareness or experience of physical symptoms without, or disproportionate to, organic etiology. Though somatic symptoms are undoubtedly influenced by biological processes, there is a psychological component. Somatic symptoms are often prevalent in various pain populations. Thus, understanding this psychological phenomenon will help understand the course of dysmenorrhea over time.

At present, pain and somatic symptoms share similar theoretical etiologies, such as familial transmission and social learning (Rousseau et al., 2014; Stone & Wilson, 2016), cognitive-affective mechanisms (Asmundson et al., 2012; Kozlowska, 2013), and central sensitization (Adams & Turk, 2018; Bourke et al., 2015). Researchers still do not fully
understand the association between somatic symptoms and pain, though they are frequently comorbid (Boerner et al., 2020). Additionally, psychological factors continue to be an important factor in determining the severity of symptoms in women with pelvic pain disorders. For example, Laganà et al. (2017) found that women with endometriosis had elevated levels of somatic symptoms. Another cross-sectional study found somatic symptoms to be the highest risk factors for chronic pelvic pain, above and beyond depressive and anxiety symptoms (Westling et al., 2013). Furthermore, women with pelvic pain frequently report higher levels of somatic symptoms, particularly those with lower levels of education (Roth et al., 2001). In a recent study, somatic symptoms have been shown to predict chronic pain 7-10 years in the future which further highlights the importance of studying this factor in dysmenorrheic populations (Brown & Lee, 2020). Taken together, these studies suggest there is an established relation between pain and somatic symptoms, which suggests that treating somatic symptoms may be one method for improving pain outcomes over time.

Research suggests that there is a strong correlation between somatic symptoms and dysmenorrhea severity. Cross-sectional studies time and again demonstrate that somatic symptoms are significantly higher in adolescents and women with dysmenorrhea as compared to healthy controls (Hellman et al., 2020; Iacovides et al., 2015; Laganà et al., 2017; Payne et al., 2019). Additionally, research shows that somatic symptoms significantly predict menstrual pain severity (Goldstein-Ferber & Granot, 2006). In one cross-sectional study including young women with dysmenorrhea, higher ratings of severe dysmenorrhea were found to be associated with somatic symptoms and chronic pain (Gagnon & Elgendy, 2020). Interestingly, research also suggests that somatic symptoms may play a larger role in the association between dysmenorrhea
and CPP/NCPP than anxiety and depression (Westling et al., 2013; Zuckerman et al., 2018). For example, one cross-sectional study found that somatic symptoms - but not depression or anxiety symptoms - mediated the relation between group membership (healthy controls, dysmenorrhea, NCPP, or NCPP + dysmenorrhea) and pelvic pain. This suggests that somatic symptoms may be a driving factor in the chronification of pain for women. In sum, research suggests that somatic symptoms and pain, including menstrual pain, are highly associated. Because most of the current research investigating somatic symptoms and menstrual pain is cross-sectional, it very well could be that there is a bidirectional association between the two constructs. Regardless of directionality, these findings further highlight the importance of the current study aim to understand whether somatic symptoms contribute to the chronicity or worsening of dysmenorrhea overtime. This study has, for first time, delineated the relation between somatic symptoms and unique patterns of change in menstrual pain, which may potentially yield intervention opportunities for women at high risk for developing heightened or chronic dysmenorrhea.

**Behavioral Factors**

**Sleep Disturbance**

Understanding behavioral factors as they relate to wellbeing and health can embolden the development of innovative treatments and preventative care plans. There are many behavioral factors that may influence levels of menstrual pain severity over time such as physical activity, smoking, and alcohol consumption (Iacovides et al., 2015; Tomás-Rodríguez et al., 2017). One behavioral factor that has been implicated with dysmenorrhea, but rarely investigated regarding how it relates to dysmenorrhea over time, is sleep disturbance. Broadly speaking, sleep
disturbance is characterized by insufficient total sleep time, awakenings during the night, sleep
onset latency, and a variety of other problems.

The connection between sleep disturbances and pain outcomes is well documented in the
literature. Research indicates that poorer sleep habits may increase pain ratings in adolescents
with chronic pain (Lewandowski et al., 2010; Palermo et al., 2007; Pavlova et al., 2020) and that
poorer sleep is related to an increase in activity limitations for adolescents with chronic pain
(Palermo et al., 2008). One cross-sectional experimental study found that healthy women (ages
18-30) experienced heightened pain sensitivity after one night of experimental sleep
fragmentation (i.e. awakenings throughout the night) during menses, which suggests that sleep
disturbances may play a role in affecting pain perception (Iacovides et al., 2017). Furthermore,
although evidence suggests there is a bidirectional relation between pain and sleep disturbance,
(e.g., Valrie et al., 2013), sleep is increasingly viewed as a stronger predictor of pain than vice
versa (Finan et al., 2013; Badawy et al., 2019).

A recent qualitative study suggests that sleep disturbance is a major physical factor
impacting adolescent and young women’s menstrual pain (Allyn et al., 2020). Although there are
biological mechanisms (e.g., prostaglandins) that are responsible for menstrual cramps but also
related to sleep regulation (Iacovides et al., 2015), research suggests that sleep disturbances may
further exacerbate pain associated with dysmenorrhea. Self-report data demonstrates there is a
link between sleep disturbances and dysmenorrhea (Sahin et al., 2014), and daytime sleepiness
and fatigue are often reported in association with menstrual cramps (Iacovides et al., 2015). Very
few studies have examined the extent to which dysmenorrhea disturbs reported sleep quality or
recorded sleep patterns (Araujo et al., 2011; Baker et al., 1999; Iacovides et al., 2009). Two
studies utilizing objective measures of sleep found that women with dysmenorrhea had lower sleep efficiency while experiencing menstrual pain compared to their pain-free phases of their menstrual cycle or the healthy control subjects (Baker et al., 1999; Iacovides et al., 2009). One cross-sectional study using unstandardized sleep questionnaires found that in adolescents, poor sleep hygiene – specifically self-reported short sleep – was negatively associated with dysmenorrhea (Gagua et al., 2012). Woosley and Lichstein (2014) examined the association between dysmenorrhea, insomnia, and sleep across the menstrual cycle in a longitudinal study including 89 women (18-24 years old) and found that an insomnia diagnosis significantly predicted dysmenorrhea severity. There were significant differences between dysmenorrhea severity groups in sleep onset latency, sleep efficiency (i.e., total sleep time divided by time in bed), and sleep quality ratings, demonstrating greater sleep disturbances in the severe dysmenorrhea group. In sum, women with mild dysmenorrhea reported better sleep quality across the entire menstrual cycle - not only during menstruation - than women with moderate or severe dysmenorrhea (Woosley & Lichstein, 2014).

Taken together, these studies suggest there is relation between menstrual pain and sleep disturbances. However, research delineating the relation between menstrual pain trajectories and sleep disturbances is critically lacking. Notably, these studies have mainly utilized cross-sectional data to characterize the relation between sleep disturbance and menstrual pain, with few exceptions (Woosley & Lichstein, 2014). An important next step is to understand how sleep disturbances relate to the chronicity or worsening of dysmenorrhea over time. Thus, the second aim of the current study was investigating if self-reported sleep disturbance at the first timepoint
can predict menstrual pain trajectory membership, such that higher ratings of sleep disturbance at the first timepoint predicted worsening or chronic menstrual pain over time.

**Covariates**

Research indicates that prior pain predicts future pain (Hunter, 2001; Katz & Seltzer, 2009). Therefore, controlling for non-menstrual-related pelvic pain collected during the screening visit is important. Additionally, the use of oral contraceptives has been shown to help some women with their menstrual pain (Harada & Momoeda, 2016). Because there is considerable overlap in depressive, anxiety, and somatic symptoms, anxiety and depressive symptoms will be included as covariates. Measures of non-menstrual-related pelvic pain, anxiety and depressive symptoms collected during the first timepoint were controlled for in the multinomial logistic regression analyses to account for the variance of these variables on trajectory membership and allow for consideration of psychological and behavioral factors beyond these variables if the preliminary analyses demonstrated a strong association. All associations between potential covariates mentioned above and menstrual pain ratings at each timepoint have been assessed prior to the decision of which covariates were included in the final analysis.

**The Current Study**

Dysmenorrhea is highly prevalent and has significant impact on current and long-term health and well-being for women across the world. Very little is known, however, about how dysmenorrhea changes over time as well as the potential predictors of those menstrual pain trajectories. Because the existing literature provides little guidance in the classification of women at greatest risk of developing severe dysmenorrhea, interventions aimed at menstrual pain
reduction have been developed without knowing which women are most likely to benefit. Furthermore, characterizing the unique patterns of change and how psychological and behavioral factors predict these patterns is critical because it may contribute to the development of effective, tailored intervention strategies. By utilizing a longitudinal design that spans two years, the current study used advanced statistical analyses to improve our understanding of menstrual pain trajectories by studying women ages 18-45 years who vary in their levels of dysmenorrhea.

**Aims and Hypotheses**

**Aim 1:** Prospectively characterize menstrual pain trajectories using repeated menstrual pain assessments at four timepoints over two years using finite mixture modeling techniques.

**Hypothesis 1:** Similar to prior research (Ju et al., 2014), we propose that four distinct trajectory groups will be identified: (1) individuals whose menstrual pain symptoms worsen; (2) individuals whose menstrual pain symptoms improve; (3) individuals whose menstrual pain symptoms remain low; and (4) individuals whose menstrual pain symptoms remain high (chronic) over two years.

**Aim 2:** Identify psychological and behavioral predictors of trajectory group membership.

**Hypothesis 2a:** Higher levels of baseline psychological symptoms (e.g., pain catastrophizing and somatic symptoms) will predict membership in constant high-pain or worsening pain trajectories, whereas lower levels of psychological symptoms will predict membership in constant low-pain or improving trajectories.

**Hypothesis 2b:** Higher levels of baseline self-reported sleep disturbance total score (e.g. low feelings of restoration associated with sleep, sleep depth, and poor sleep quality) will predict membership in the constant high-pain or worsening pain trajectories, whereas lower levels of
sleep disturbance will predict membership in the constant low-pain or improving pain trajectories.
CHAPTER TWO

METHOD

Participants

The present study included $n = 345$ women ages 18-45 who were recruited by flyers, online advertisements through Craigslist, and by referral from local gynecology clinics. These participants were mostly white (65.8%), single (75.65%), and nulliparous (87.25%). Only participants who completed at least two of three timepoints (e.g., screening visit, year 1 following up and year 2 follow up; $n = 157$; see Figure 1) were included in the present study, as a minimum of two timepoints is necessary for conducting linear trajectory analyses (Aim 1). Participants received compensation for completing the screening visit ($25), assessment visits ($150), and the annual follow-up surveys ($10). The larger study is scheduled to collect five years of annual follow-up data; thus, data collection is ongoing. To assure the most robust sample possible with the least missing data, the current study only used data from the screening visit and the first two yearly follow-up time points.
Procedure

This study was approved by the NorthShore University Health System Institutional Review Board. To determine eligibility, potential participants were instructed to call the study team and complete a phone screen. See Figure 2 for a visualization of participant retainment. Participants were not included in this specific study focusing on dysmenorrhea if they had current pelvic or abdominal malignancies, active genitourinary infection within the past four weeks, amenorrhea (absence of regular menses), inability to read or comprehend informed consent in English, refusal to undergo pelvic examination, hypertension, or refusal to withdraw from OCs for two months prior to the assessment visit. The following criteria were used to identify women with moderate dysmenorrhea (a) average menstrual pain $\geq 5/10$ ($0 =$ no pain and $10 =$ the worst imaginable pain) during menses or withdrawal uterine bleeding from cyclic oral contraceptives (OCs) without painkillers, (b) menstrual pain in the region between the umbilicus and the perineum, above the level of the inguinal ligament, and (c) an indication the participant
has attempted to resolve pain by medical means (including NSAIDs and/or OCPs). Other women were included in the study as healthy controls if they rated their pain ≤ 3/10 (0 = no pain and 10 = the worst imaginable pain) during menses or withdrawal uterine bleeding from cyclic oral contraceptives (OCs) without painkillers and without chronic pain diagnoses. Informed consent was obtained from each participant prior to performing any tests or filling out any questionnaires. Following the screening phone call, if eligible, participants were scheduled for an initial in-person screening visit, which included administering self-report questionnaires on gynecological history, medical history, and mental health evaluations. To confirm the likelihood that participants had primary dysmenorrhea, the screening visit was completed by a board-certified Ob/Gyn with pain fellowship training. Ultrasound evaluation was performed for further confirmation when necessary. Eligible participants completed daily pain diaries to confirm menstrual pain. Additionally, they were asked to abstain from using birth control pills for the duration of the study. Eligible participants were then scheduled for a mid-luteal phase assessment visit, approximately 17-25 days after commencement of menses. All participants went into follow-up after their mid-luteal phase assessment visit. The follow-up assessments included administering self-report questionnaires on gynecological history, medical history, and mental health evaluations once every five years.
Note. The larger study assessed 379 participants via an in-person screening visit. Of those 379, only 250 completed the in-person assessment visit. Following the assessment visit, participants went into follow-up, which consists of five annual online surveys. The current study included those individuals who completed two or more of the following visits: screening visit, year 1 follow-up, and year 2 follow-up.

Figure 2. Current Study Sample

Measures

Demographics

During the in-person screening visit participants completed a basic demographic questionnaire, including their age, race, ethnicity, marital status, education, and pregnancies.

Dysmenorrhea

Participants responded to questions related to menstrual pain during a screening phone interview, in-person screening visit, and two annual yearly follow-ups. The in-person screening visit and two online annual follow-ups consisted of self-report measures evaluating participants’ menstrual pain (e.g., Please use the slider to indicate the average amount of cramping or pain you
have experienced during your menstrual period over the PAST 3 MONTHS when NOT taking any painkillers and on the worst day of your period? The scale is 0 to 100, with “0” being no pain and “100” being the worst pain imaginable).

**Pain Catastrophizing**

The 13-item Pain Catastrophizing Scale (PCS) was administered at the screening visit (Sullivan et al., 1995). The PCS is a widely used self-report questionnaire that consists of three subscales of rumination, magnification, and helplessness as it relates to past painful experiences. Respondents are asked to indicate on a 5-point Likert scale from 0 (not at all) through 4 (all the time) the extent to which they experienced the 13 thoughts or feelings when experiencing pain. In the present sample, internal consistency was excellent ($\alpha=.93$).

**Somatic Symptoms**

The somatization subscale of the Brief Symptoms Inventory-18, a self-report measure that assesses psychological distress on three dimensions: depression, anxiety, and somatization (Derogatis & Melisaratos, 1983), was used to capture somatic symptoms. The BSI-18 is a broadly used self-report questionnaire that consists of eighteen descriptions of physical and emotional complaints. Respondents are asked to indicate on a 5-point Likert scale from 0 (not at all) through 4 (very much) to what extent they are troubled by the complaints (Kellett et al., 2003). The somatization subscale is scored by summing distinct items within that subscale, with a raw subscale score ranging from 0 to 24, with elevated scores indicating higher levels of somatization (Derogatis, 2001). In the current study, participants completed the somatization subscale during the screening visit, which showed good internal consistency ($\alpha=.8$).
Sleep Disturbance

Participants completed the Patient Reported Outcomes Measurement Information System (PROMIS) Short Form to evaluate sleep disturbances. The PROMIS Short form sleep disturbance scale each consists of eight items within a seven-day time frame and a five-point Likert scale (Cella et al., 2010). Sleep disturbance scale item content focuses on restoration associated with sleep, sleep depth, and sleep quality. The PROMIS short form was developed for use in both clinical and research settings. In the current study, participants completed this measure during the screening visit and in the present sample, internal consistency was excellent (α=.91).

Covariates

Baseline measures of non-menstrual-related pelvic pain, age, childbirth, oral contraceptive use, anxiety, and depression were evaluated as potential covariates. Non-menstrual-related pelvic pain was measured by asking participants if they “have pelvic, bladder, or abdominal pain that persists outside of [their] menstrual period.” Anxiety and depressive symptoms were measured at the screening visit with NIH PROMIS Anxiety and Depression subscales, 7- and 8-item measures with Likert scales. Age was measured during the screening visit. Internal consistency for both anxiety (α=.93) and depressive symptom (α=.95) scales was excellent.

Plan of Analyses

Descriptive Statistics

Descriptive statistics were calculated in R-Studio to determine the psychometric properties of all measures, which included Cronbach alphas, means, standard deviations, and
scale ranges. Outlier (as defined by a z-score > 3.30) and skewness analyses were conducted. Because GMM and multinomial logistic regression analyses do not assume normality, any outliers detected in the data were investigated, however not removed. Initially, age, non-menstrual-related pelvic pain, and anxiety and depressive symptoms were correlated with menstrual pain ratings at each time point to determine if they should be used as covariates in the multinomial logistic regression analysis. Additionally, childbirth status and oral contraceptive use (both yes/no variables) were correlated with menstrual pain ratings at each time point using Spearman’s Correlation to determine if it should be included as time-varying covariates in the trajectory analysis after class enumeration has been established.

**Analytic Plan for Aim 1: Determining Menstrual Pain Trajectories**

**Trajectory modelling.** First, all participants’ longitudinal menstrual pain data were plotted to provide a visual representation of whether enough heterogeneity of menstrual pain is evident in the data to justify the use of mixture modelling (i.e., spaghetti plot). The next step was to fit a one-class model (growth curve model; GCM) to the data. This GCM was used to compare subsequent models to justify multiple sub-group solutions. GCM, using a linear mixed effects model, was estimated in R-Studio using the latent class mixture modeling (LCMM) package (Proust-Lima et al., 2017) to establish the baseline model for the subsequent GMM that investigated the trajectory of change in menstrual pain over time, as defined by study timepoints.

To identify multiple latent classes of menstrual pain, a longitudinal finite mixture model (FMM) was used. FMMs can capture variation in menstrual pain patterns between and within individuals and the assignment of a participant to a subgroup (i.e., class) is based on the degree of similarity of menstrual pain between individuals. To do this, polynomial orders and maximum
$K$ (number of subgroups) were determined using both practical and theoretical insight (Grimm et al., 2016; Nagin, 2014; Nagin & Tremblay, 2005; van der Nest et al., 2020). The likelihood for menstrual pain to increase or decrease over time is similar (Weissman et al., 2004), and the only study thus far to investigate menstrual pain trajectories found four distinct groups (Ju et al., 2014). Therefore, the current study predicted the number of identifiable subgroups would be four, resulting in a maximum $k=5$. The highest sensible polynomial order was determined by visually inspecting the shape and size of the various trajectories via a spaghetti plot (van der Nest et al., 2020). Next, a growth mixture model (GMM) was fit increasing in $k$ (from $k=2$ up to the determined maximum $k=5$), and the model with the best fit was selected. Model fit was evaluated by using a multiple fit indices taken into consideration in tandem with prior research, theory, and clinical judgment regarding menstrual pain (Frankfurt et al., 2016; Grimm et al., 2016; van de Schoot et al., 2017; van der Nest et al., 2020). It is important to consider both statistical and conceptual issues when deciding best model fit. Importantly, fit statistics do not provide absolute benchmarks for “accuracy” or “exactness” but instead compare relative fit among models (Frankfurt et al., 2016).

For this study the following information criteria (IC) related to parsimony were utilized: the Bayesian Information Criterion (BIC), sample-size-adjusted BIC (ssBIC), Akaike’s Information Criterion (AIC), and Consistent AIC (CAIC). Generally, model selection is based on the lowest value for ICs. Each IC vary in their level of penalization for model complexity which can be considered on a continuum. The AIC has the lowest penalty (e.g., favors more classes) and BIC/CAIC having the highest penalty (e.g., favoring fewer classes) with ssBIC landing in the middle of the continuum. In addition to the ICs listed above, entropy-based ICs were also
used. Entropy-based measures are based on whether the model produces classes that are well separated. These measures help with selecting a model with optimal class separation which is important because it allows for confidence in the class membership assignment (van de Schoot et al., 2017). The following entropy-based ICs (related to clustering) were used: Classification likelihood criterion (CLC), Integrated Completed Likelihood Criterion with BIC approximation (ICL-BIC), Normalized Entropy Criterion (NEC), and Entropy (E. Like BIC, ssBIC, AIC, and CAIC, smaller values for CLC, ICL-BIC, and NEC are preferred. For example, a NEC of 0 would indicate a perfect clustering. For entropy, the range is 0 to 1 with higher values are preferred. Specifically, an entropy of >.8 is best with ~.7 indicating generally acceptable classification (Frankfurt et al., 2016b; van de Schoot et al., 2017).

These statistics (e.g., ssBIC, BIC, etc.) have been compared to the adjusted $R^2$ since it incorporates model complexity and overall fit, penalizing convoluted solutions. Although time-varying covariates are possible, it is oftentimes better to proceed with the class enumeration process (i.e., deciding on the number of classes) without time-varying or invariant covariates because covariates will change the latent class trajectories (van de Schoot et al., 2017). For this reason, time-varying or invariant covariates were not included in the trajectory analyses.

**Analytic Plan for Aim 2: Predicting Menstrual Pain Trajectory Membership with Baseline Psychological and Behavioral Factors**

A multinomial logistic regression was used, with baseline variables of pain catastrophizing, somatic symptoms, and sleep disturbance predicting menstrual pain trajectory membership. The trajectories identified in Aim 1 were used as the dependent variable in the logistic regression. Identified covariates (e.g., anxiety and depressive symptoms, and non-
menstrual related pelvic pain) were included in the multinomial logistic regression model since theory and preliminary analyses suggest they were significantly associated with menstrual pain ratings at multiple timepoints and if they do not pose collinearity or additivity threats (i.e., risk of introducing suppression effects). Importantly, one class served as the reference group. Typically, the reference group would be the “normative” group. However, this study is specifically interested in understanding difference between women who experience high or chronic levels of menstrual pain and other potentially identified sub-groups. This means if the analysis in Aim 1 identified such a group, a high-stable group would serve as the reference group.

**Power Analyses**

Power analyses are used to understand the ability to identify subgroups in a sample, the power to identify significant effects, and the power to identify specific significant predictors of identified subgroups. There is very little discussion of power analyses of the growth mixture modeling literature, though typically power analyses are the first step of any data analysis plan. Further, power analyses are typically discussed in the limitation section suggesting that smaller samples sizes result in lower power to detect effects (Frankfurt et al., 2016). Research studies using finite mixture modeling techniques with sample sizes as small as \( n = 132 \) have identified three subgroup trajectories with 10 comparison variables, six of which significantly predicted subgroup membership (Mulvaney et al., 2006). Thus, this sample of 157 participants appears to provide ample statistical power to detect effects for the proposed analyses.
CHAPTER THREE

RESULTS

Preliminary Analysis

Descriptive statistics for main study variables are reported in Table 1. After creating composite scores, all variables were examined for outliers and then skewness. Cronbach Alphas for all measures were adequate (i.e., $\alpha > .70$; Ferketich, 1990). No outliers (as defined by a z-score $> 3.30$) were identified. Next, variables were considered highly skewed if their skewness value was greater than +/- 1.0. The Somatic Symptoms composite was highly positively skewed (1.8); however, GMM and multinominal logistic regression do not assume a normal distribution (Frankfurt et al., 2016) thus no outliers were excluded from the data, nor were variables transformed to achieve a normal distribution.

Prior to hypothesis testing, Pearson and Spearman correlations were conducted to examine associations between menstrual pain ratings and psychological and behavioral factors, as well as demographic information, both cross-sectionally and longitudinally. Menstrual pain ratings at each timepoint were positively correlated, as expected (see Table 1). Results revealed several significant correlations between menstrual pain, psychological, and behavioral factors. In general, women who experienced high levels of baseline menstrual pain also endorsed experiencing pelvic pain outside of the menstrual cycle at the screening visit (i.e., strong positive association with non-menstrual related pelvic pain). Notably, this association did not hold for year 1 and year 2 follow up menstrual pain ratings. Greater levels of non-menstrual related pelvic
pain were associated with higher levels of somatic symptoms, pain catastrophizing, sleep disturbances, and anxiety symptoms, but not depressive symptoms. Age was positively correlated with number of pregnancies and non-menstrual related pelvic pain. Interestingly, age was not significantly correlated with number of deliveries. High levels of baseline menstrual pain were associated with more somatic symptoms, pain catastrophizing, and sleep disturbance, as expected. Interestingly, higher levels of year 1 follow up menstrual pain were associated with higher levels of pain catastrophizing at the screening visit, but it was not significantly associated with any other variable. Higher levels of menstrual pain at the year 2 follow up were associated with higher levels of somatic symptoms only. Somatic symptoms, pain catastrophizing, sleep disturbances, and anxiety and depressive symptoms were all positively correlated with one another. Contrary to prior research, age and childbirth were not significantly related to menstrual pain ratings at any time point. Correlation coefficients for associations between demographic information, psychological and behavioral functioning, and non-menstrual related pelvic pain at the screening visit and menstrual pain at the screening visit, year 1 follow up, and year 2 follow up are presented in Table 1.
Table 1. Means, Standard Deviations, and Correlations of Key Study Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>$M$</th>
<th>$SD$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age</td>
<td>25.11</td>
<td>6.37</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Screening MP</td>
<td>58.76</td>
<td>27.17</td>
<td>.01</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3. Year 1 MP</td>
<td>47.58</td>
<td>28.80</td>
<td>.02</td>
<td>.60**</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4. Year 2 MP</td>
<td>49.35</td>
<td>28.78</td>
<td>-.13</td>
<td>.49**</td>
<td>.60**</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>5. Pregnancies</td>
<td>0.15</td>
<td>0.47</td>
<td>.37**</td>
<td>.03</td>
<td>.03</td>
<td>-.00</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6. Deliveries</td>
<td>0.44</td>
<td>0.78</td>
<td>.34</td>
<td>-.11</td>
<td>-.45</td>
<td>-.19</td>
<td>.67**</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7. Vaginal</td>
<td>0.39</td>
<td>0.78</td>
<td>.26</td>
<td>-.13</td>
<td>-.39</td>
<td>-.24</td>
<td>.72**</td>
<td>.95**</td>
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<td></td>
</tr>
<tr>
<td>8. SS</td>
<td>3.49</td>
<td>3.85</td>
<td>-.11</td>
<td>.30**</td>
<td>.15</td>
<td>.20*</td>
<td>.06</td>
<td>-.02</td>
<td>.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. PC</td>
<td>15.76</td>
<td>11.67</td>
<td>.03</td>
<td>.33**</td>
<td>.18*</td>
<td>.08</td>
<td>-.02</td>
<td>-.29</td>
<td>-.27</td>
<td>.32**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. SD</td>
<td>19.38</td>
<td>6.83</td>
<td>.15</td>
<td>.24**</td>
<td>.08</td>
<td>.12</td>
<td>.10</td>
<td>.14</td>
<td>.04</td>
<td>.52**</td>
<td>.23**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Anxiety</td>
<td>16.20</td>
<td>6.25</td>
<td>-.03</td>
<td>.08</td>
<td>.10</td>
<td>.05</td>
<td>-.06</td>
<td>.21</td>
<td>.21</td>
<td>.55**</td>
<td>.25**</td>
<td>.51**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Depression</td>
<td>15.39</td>
<td>6.93</td>
<td>-.07</td>
<td>.11</td>
<td>.06</td>
<td>-.01</td>
<td>-.14</td>
<td>.21</td>
<td>.20</td>
<td>.45**</td>
<td>.20*</td>
<td>.41**</td>
<td>.79**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. *NPP</td>
<td>24</td>
<td>16%</td>
<td>.30**</td>
<td>.22*</td>
<td>.21</td>
<td>.10</td>
<td>.01</td>
<td>-.40</td>
<td>-.40</td>
<td>.23*</td>
<td>.38*</td>
<td>.32*</td>
<td>.26*</td>
<td>.18</td>
<td></td>
</tr>
<tr>
<td>14. *OC</td>
<td>33</td>
<td>21%</td>
<td>-.09</td>
<td>-.09</td>
<td>-.15</td>
<td>-.09</td>
<td>-.13</td>
<td>-.15</td>
<td>-.13</td>
<td>-.12</td>
<td>-.01</td>
<td>-.19*</td>
<td>-.06</td>
<td>-.12</td>
<td>-.01</td>
</tr>
</tbody>
</table>

Note. * Indicates $p < .05$. ** indicates $p < .01$; MP = Menstrual pain, SS= Somatic Symptoms, PC = Pain Catastrophizing, SD = Sleep Disturbances, NPP= Non-menstrual-related pelvic pain, OC = Oral contraceptives; *Spearman’s Correlation (response variable yes/no)
Growth Mixture Modeling

For trajectory analyses, study timepoint was entered as the predictor variable to better understand how menstrual pain changes across time. After plotting longitudinal data of menstrual pain ratings for all participants, it was clear that there was enough variability to proceed with modeling (see Figure 3). Using data from three timepoints, the linear GCM was conducted. The linear GCM suggested that on average women reported moderate clinical levels of menstrual pain at baseline (intercept = 56.23) that significantly decline over time (linear slope $\beta = -3.82$, $SE = 1.07$), with mean scores of 47.58 at year 1 and 49.35 at year 2 follow ups. Significant variance was found around the intercept and linear slope which suggest that several women reported initial menstrual pain scores and change in menstrual pain scores overtime that diverged from the “average” response.

Because it was determined that there was significant variability in the intercept and slope growth parameters, GMM was used to assess whether groups of women followed similar menstrual pain patterns of change over time. Specifically, two- through five-class linear GMMs were run, testing to see what number of classes best fit the data during the class enumeration process (see Figure 4). As shown in Table 2, the three-class solution had the lowest parsimony IC statistics, whereas two-and-four class solutions had the better clustering IC statistics. Deciding between a two-three-or four-class solutions, all IC statistics, prior research, and clinical utility were all considered. The two-class solution was not chosen because there was large variability within class. The three-class solution was not chosen because although it did have the lowest AIC/BIC/ssBIC, there were drastically different intercepts and slopes identified within class 3 depicted in green (see Figure 5). When visualizing the fitted lines for each participant
broken down into either four or three-class, the four-class solution better captures the variability seen within class 3 of the three-class solution (see Figure 6). Notably, when comparing the three and four class solutions, entropy statistics (CLC, NEC, and E) all favor a four-class solution, which supports the data visualization, differences noted above. Finally, most parsimony and clustering ICs had less than a 10-point difference between three-and-four class solutions which suggests that the three-class solution does not definitively fit better than the four-class solution for most ICs (Frankfurt et al., 2016). Thus, the four-class linear model was identified as the best model (see Table 2 for parameter estimates; see Figure 7 for mean predicted trajectories).

Note. All participants’ longitudinal menstrual pain data were plotted for visual inspection of variability within the sample.

Figure 3. Spaghetti Plot of Longitudinal Menstrual Pain
To decide on the number of classes identified using GMM, several fit indices were calculated. This figure is a visualization of the differences in fit by plotting the values of the penalized likelihood indices.

Figure 4. Plot of Fit Indices for Class Enumeration

Note. To decide on the number of classes identified using GMM, several fit indices were calculated. This figure is a visualization of the differences in fit by plotting the values of the penalized likelihood indices.
Note. To visualize the dispersion of the random effects in GMM of a three-class salutation, subject-specific predicted values (i.e., predicted individual trajectories) were plotted. The bottom cluster of lines (black, Class 1) and top cluster of lines (red, Class 2) represents trajectories for the low-and-high-stable classes. These classes show very little variation and are largely homogeneous. In contrast, trajectories in the middle cluster (green, Class 3) show a great deal of quantitative variation within class.

Figure 5. Three-Class Individual Fitted Lines
Note. To visualize the dispersion of the random effects in GMM of a four-class solution, subject-specific predicted values (i.e., predicted individual trajectories) were plotted. The top cluster of lines (black, Class 1) and bottom cluster of lines (red, Class 2) represents trajectories for the high-and-low-stable classes. These classes show little variation and are mostly homogeneous. In contrast, trajectories in the middle clusters (blue, Class 3; green Class 4) show more quantitative variation within class.

Figure 6. Four-Class Individual Fitted Lines

Table 2. Fit Indices for Two-to-Five Class Solutions of Growth Mixture Models

<table>
<thead>
<tr>
<th>Classes</th>
<th>AIC</th>
<th>BIC</th>
<th>CAIC</th>
<th>ssBIC</th>
<th>Parsimony Criteria</th>
<th>Clustering Criteria</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CLC</td>
<td>NEC</td>
<td>E</td>
</tr>
<tr>
<td>2</td>
<td>4392.18</td>
<td>4422.74</td>
<td>4432.74</td>
<td>4391.09</td>
<td>4396.13</td>
<td>0.42</td>
<td>0.89</td>
</tr>
<tr>
<td>3</td>
<td><strong>4378.33</strong></td>
<td><strong>4421.12</strong></td>
<td><strong>4435.12</strong></td>
<td><strong>4376.8</strong></td>
<td>4439.26</td>
<td>1.12</td>
<td>0.74</td>
</tr>
<tr>
<td>4</td>
<td>4381.6</td>
<td>4436.61</td>
<td>4454.61</td>
<td>4379.63</td>
<td><strong>4427.69</strong></td>
<td>0.98</td>
<td>0.81</td>
</tr>
<tr>
<td>5</td>
<td>4386.02</td>
<td>4453.26</td>
<td>4475.26</td>
<td>4383.62</td>
<td>4485.53</td>
<td>1.64</td>
<td>0.72</td>
</tr>
</tbody>
</table>
The mean predicted trajectories for each class are plotted here to demonstrate the mean slopes- or rate of change in menstrual pain- for each class.

Figure 7. Four-Class Mean Predicted Trajectories

For each of the four classes, the effect size for change in menstrual pain was calculated by subtracting the year 2 follow-up mean menstrual pain score in the class from the baseline mean menstrual pain score for the class, and then dividing the difference by the standard deviation of the subsample at baseline, and were interpreted using effect size guidelines (Sawilowsky, 2009). These four classes suggest that 63% of the sample (i.e., “high-stable,” \( n = 103 \), Class 1) reported high initial levels of menstrual pain that remained relatively stable over time with a medium effect size \( (d = 0.54) \). An additional 15% of the sample (i.e., “low-stable,” \( n = 25 \), Class 2) reported a low level of menstrual pain that remained relatively stable over time.
with a small effect size ($d = 0.26$). Another 10.6% of the sample (i.e., “improving,” $n = 14$, Class 3) reported high initial levels of menstrual pain that improved over the course of the study with a huge effect size ($d = 4$). Finally, 11.4% of individuals (i.e., “worsening,” $n = 15$, Class 4) reported low levels of menstrual pain at the screening visit that increased over time with a very large to huge effect size ($d = -1.89$).

**Multinomial Logistic Regression**

To predict the differences between classes, using the “high-stable” class as the reference class, multinomial logistic regressions were conducted. Preliminary inspection of the data indicated a possibility of multicollinearity. Anxiety and depressive symptoms were strongly correlated ($r = .79$) but did not quite meet the threshold for exclusion ($r = .9$). Predictor variables included non-menstrual related pelvic pain (NMPP), anxiety, depressive symptoms, somatic symptoms, pain catastrophizing, and sleep disturbances. Descriptive statistics for the psychological and behavioral factors for each subgroup are included in Table 3.
Table 3. Growth Mixture Model Parameters and Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High-Stable</td>
<td>Low-Stable</td>
<td>Improving</td>
<td>Worsening</td>
</tr>
<tr>
<td><strong>Fixed Effects</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Intercept</td>
<td>69.63**</td>
<td>11.11**</td>
<td>70.91**</td>
<td>25.71**</td>
</tr>
<tr>
<td>Mean Slope</td>
<td>-3.27*</td>
<td>-1.44</td>
<td>-27.53**</td>
<td>11.86**</td>
</tr>
<tr>
<td><strong>Random Effects</strong></td>
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<tr>
<td>Variance in Intercepts</td>
<td>31.06</td>
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<td></td>
</tr>
<tr>
<td>Variance in Slopes</td>
<td>8.16</td>
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<td></td>
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<tr>
<td>Intercepts and Slopes</td>
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<tr>
<td><strong>Descriptive Statistics</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>M (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>4.01 (4.1)</td>
<td>1.28 (1.99)</td>
<td>4.5 (4.128)</td>
<td>2.67 (2.85)</td>
</tr>
<tr>
<td>PC</td>
<td>16.85 (1.129)</td>
<td>11.24 (11.13)</td>
<td>18.64 (13.37)</td>
<td>(12.21)</td>
</tr>
<tr>
<td>SD</td>
<td>20.26 (6.78)</td>
<td>16.16 (6.56)</td>
<td>20.21 (6.69)</td>
<td>17.87 (6.46)</td>
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<tr>
<td>Anxiety</td>
<td>16.24 (6.29)</td>
<td>13.68 (5.35)</td>
<td>18.07 (6.29)</td>
<td>18.33 (6.49)</td>
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<tr>
<td>Depression</td>
<td>15.32 (7)</td>
<td>13.64 (5.94)</td>
<td>18.86 (7.6)</td>
<td>15.6 (6.82)</td>
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<td><strong>Goodness-of-fit</strong></td>
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</tr>
<tr>
<td>AIC</td>
<td>4381.6</td>
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</tr>
<tr>
<td>BIC</td>
<td>4436.6</td>
<td></td>
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</tr>
</tbody>
</table>

* *p < .05. ** *p < .001; SS= Somatic Symptoms, PC = Pain Catastrophizing, SD = Sleep Disturbances

Overall, the model which included non-menstrual-related pelvic pain, and psychological and behavioral factors was predictive of group classification, $X^2(21) = 38.52, p = .003$; McFadden $R^2 = .20$ and correctly classified 65.6% of all participants. Specifically, 95% of those in the high-stable subgroup were classified correctly. However, only 12.5% of the improving subgroup, 6.7% of low-stable subgroup, and 20% of the worsening subgroup participants were classified accurately (see Table 4 for parameter estimates for the equations). When classifying the difference between high-stable and low-stable groups, none of the predictors were significant.
When classifying the difference between high-stable and improving groups, only depressive symptoms were significant. The results show that “improving” symptom individuals had more depressive symptoms at the screening visit compared with the high-stable group (see Figure 8). When classifying the difference between the high-stable and worsening groups, only somatic symptoms were significant. This means that individuals in the high-stable group had significantly higher levels of somatic symptoms at the screening visit as compared to those in the worsening group (see Figure 9). In contrast to stated hypotheses, pain catastrophizing and sleep disturbance were not significant when classifying the difference between high-stable and other groups. However, results suggested pain catastrophizing was marginally significant ($p=.078$) when classifying the difference between high-stable and worsening groups with the high-stable group reporting higher levels of pain catastrophizing at the initial visit than the worsening group individuals (see Table 4).
Note. Participants in each of the 4 groups rated their depressive symptoms. Participants in the improving group reported the highest number of depressive symptoms during the screening visit as compared to the other groups. Box plots indicate median, 25th, and 75th percentile.

Figure 8. Boxplot of Depressive Symptoms by Class
Participants in each of the 4 groups rated their somatic symptoms. Participants in the worsening group reported the highest number of somatic symptoms during the screening visit as compared to the other groups. Box plots indicate median, 25th, and 75th percentile.

Figure 9. Boxplot of Somatic Symptoms by Class

Note. Participants in each of the 4 groups rated their somatic symptoms. Participants in the worsening group reported the highest number of somatic symptoms during the screening visit as compared to the other groups. Box plots indicate median, 25th, and 75th percentile.
Table 4. Psychological and Behavioral Predictors for the Classification of Menstrual Pain Trajectory Groups

<table>
<thead>
<tr>
<th>Patient Diagnosis</th>
<th>b</th>
<th>Std. Error</th>
<th>z-value</th>
<th>Sig.</th>
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<tr>
<td>Low-Stable</td>
<td>-0.93</td>
<td>1.11</td>
<td>-0.84</td>
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<tr>
<td>NMPP</td>
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<td>1687.90</td>
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<tr>
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<tr>
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<td>0.20</td>
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<tr>
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<td>0.04</td>
<td>-0.58</td>
<td>0.563</td>
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<tr>
<td>Sleep Disturbances</td>
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<td>0.06</td>
<td>-0.40</td>
<td>0.689</td>
</tr>
<tr>
<td>Improving</td>
<td>-2.46</td>
<td>1.55</td>
<td>-1.59</td>
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</tr>
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<tr>
<td>Sleep Disturbances</td>
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<td>0.06</td>
<td>-1.25</td>
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</table>

*Note.* “High-stable” class is the reference category, $df = 2$.

* $p < .05$. 
CHAPTER FOUR
DISCUSSION

The purpose of this study was to use a data-driven approach to more fully characterize heterogeneity in a sample of women with varying levels of dysmenorrhea over time. In order to better understand the complexities of menstrual pain, this study used sophisticated longitudinal analyses to replicate prior research that suggested that over time, menstrual pain can remain stable, improve, or worsen (Weissman et al., 2004), and that four distinct patterns of menstrual pain emerge (Ju et al., 2014). Additionally, this study sought to extend prior research suggesting that menstrual pain is related to psychological and behavioral factors by investigating menstrual pain latent trajectories instead of using cross-sectional data to better understand how psychological and behavioral factors contribute to patterns of menstrual pain over time. Prior research has demonstrated a positive association between menstrual pain and various psychological (e.g., depressive, anxiety, somatic symptoms, and pain catastrophizing) and behavioral (e.g., sleep disturbance) factors (Allyn et al., 2020; Evans et al., 2021; Gagua et al., 2012; Hellman et al., 2020), but most of these studies are cross-sectional in nature. No prior research has examined baseline measures of psychological and behavioral factors in relation to menstrual pain trajectories, let alone latent trajectories.

Interestingly, age, childbirth, and oral contraceptive use were not associated with menstrual pain at any timepoint. This finding is interesting in that most prior research suggests that decreases in menstrual pain are sometimes associated with oral contraceptive use, older age,
and childbirth (Harada & Momoeda, 2016; Weissman et al., 2004; Westling et al., 2013).

Further, menstrual pain was not associated with depression or anxiety at any timepoint which suggests that the current study’s other psychological predictors (i.e., somatic symptoms & pain catastrophizing) are indeed uniquely related to menstrual pain.

A crucial takeaway of this study is that there are unique patterns of menstrual pain in a normative sample of women with varying levels of dysmenorrhea. In line with the hypotheses, and with prior research (Ju et al., 2014), four distinct menstrual pain trajectory subgroups were identified in the sample. This suggests that, though menstrual pain is highly variable, there are generally four unique patterns that emerge over time. There are low-or-high levels of menstrual pain that remain stable over time, low initial levels of menstrual pain that worsen over time, and high initial levels of menstrual pain that improve significantly over time. This suggests that other factors are contributing to these experiences of pain beyond menstrual cramps. Ju et al. used a similar finite mixture modeling technique to identify groups and investigated group differences based on demographic information. The current study is the first to use this type of data-driven analysis to investigate psychological and behavioral differences between identified groups. By comparing these patterns via modifiable factors, not just demographic information, potential interventions can be explored further.

The multinomial logistic regression, as expected, revealed that somatic symptoms predicted differences between group membership. Specifically, when classifying the difference between high-stable and improving symptoms group, depressive symptoms were significant. Interestingly, the improving symptoms group had higher levels of depressive symptoms at the initial visit as compared with the high-stable subgroup. This suggests that those who had high
menstrual pain at the screening visit but experienced an improvement in symptoms over time had higher levels of depressive symptoms at the screening visit than those with chronic, or stable levels of menstrual pain. Prior research suggests that depressive symptoms are common among pain populations, including individuals with dysmenorrhea (Allyn et al., 2020). It is notable that depressive symptoms did not correlate with menstrual pain at any timepoint, suggesting this phenomenon is unique to the improving symptoms subgroup trajectory. These results, however, beg the question whether depressive symptoms remitted in tandem with menstrual pain over time.

Additionally, comparing individuals in the high-stable versus worsening subgroups, those with worsening menstrual pain had lower levels of somatic symptoms at the initial visit than those in the high-stable subgroup. Notably, when comparing between the high-stable group and the low-stable and improving symptoms groups, there were no significant comparisons based on somatic symptoms. This means that individuals with stable (high or low) and improving symptoms over time do not significantly differ on baseline measures of somatic symptoms. This is somewhat counterintuitive considering that research suggests a relation between menstrual pain and somatic symptoms, so one would expect to see differences between low-stable and high-stable groups based on somatic symptoms. Importantly, this may suggest that higher levels of somatic symptoms may predict chronic trajectories of dysmenorrhea. Though individuals in the worsening group still had high levels of menstrual pain at the year 2 follow-up, the high-stable group had significantly higher levels of somatic symptoms at the initial visit.

Contrary to the hypotheses, anxiety, pain catastrophizing, and sleep disturbances were unrelated to menstrual pain trajectory subgroups. Prior research has not examined relations
between these variables and menstrual pain trajectories. There has been support from cross-sectional research that suggests relations between menstrual pain and pain catastrophizing and sleep disturbances more broadly, indicating that heightened pain catastrophizing and sleep disturbances may influence menstrual pain (Evans et al., 2021; Iacovides et al., 2013, 2017; Lee et al., 2018; Payne et al., 2016; Tomás-Rodríguez et al., 2017). One explanation for the lack of findings in the current study was the low power to observe weak or moderate effects. The disproportionate subgroup sizes likely impacted the results of the multinomial logistic regression. For example, the high-stable group \( n = 106 \) was approximately 7 times larger than the improving group \( n = 14 \). This is demonstrated by the very low prediction accuracy of the model which included non-menstrual related pelvic pain, and psychological and behavioral predictors of group membership for the improving, low-stable, and worsening subgroups.

**Limitations and Future Directions**

There were several limitations to this study. First, there are noteworthy sampling limitations. The sample is majority White (65.8%) and is mostly comprised of college students, limiting the generalizability of the results. Second, the current study specifically recruited individuals with ≥5 (dysmenorrhea) or ≤3 (healthy controls) on a 0-10 scale of menstrual pain during the screening interview. This means that the current sample is not thoroughly representative of menstrual pain levels in a normative sample. Future studies should consider including individuals reporting a full range of menstrual pain levels at baseline. As discussed previously, secondary dysmenorrhea can be associated with later onset of menstrual pain, which means by not differentiating between primary and secondary dysmenorrhea, it may be possible that the worsening symptom subgroup is comprised of individuals with secondary dysmenorrhea.
only and cannot be generalizable to those with primary dysmenorrhea. However, research conducted with the current sample suggests that distinguishing between primary and secondary dysmenorrhea may not be hugely impactful. Hellman et al. (2020) reported that of the 98 dysmenorrhea patients examined by a gynecologist, only four were confirmed secondary dysmenorrhea. Due to participant burden, these exams and ultrasounds were discontinued because they rarely detected secondary dysmenorrhea. Next, the data are all self-report. Future studies should consider including daily diaries to examine menstrual pain and other psychological and behavioral factors because daily diary methods potentially reduce recall bias as participants report more frequently. In addition to more frequent sampling via daily diaries, future studies should consider using objective measures of sleep (i.e., actigraphy) to characterize sleep disturbances which might provide more accurate estimates of sleep variables. Additionally, future studies should consider using objective measures of pain (i.e., lab-based measures of pain) instead of a binary (yes/no) variable to control for other non-menstrual related pain. Further, the current study did not differentiate between primary and secondary dysmenorrhea.

In the current study, no association was found between GMM identified subgroups and pain catastrophizing and sleep disturbances. Prior cross-sectional research would suggest that pain catastrophizing and sleep disturbances would be predictive of menstrual pain trajectories, but this study did not find these variables to be predictive of group membership. As discussed previously, this may be due to the uneven distribution of participants between subgroups. When running a multinomial logistic regression, it is much hard to predict smaller groups. The current study had a group that was comprised of only 14 individuals. This greatly limited the study. An alternative explanation of the current findings could be related to directionality. Perhaps pain
catastrophizing and sleep disturbances did not predict group membership because these constructs are a result of menstrual pain experiences. Using screening visit factors to predict change over time suggests that they may be mechanistically associated with menstrual pain. However, it could be that pain catastrophizing emerges as a maladaptive coping technique, as suggested by prior qualitative research findings (Allyn et al., 2020). Though prior research does suggest that sleep is more predictive of pain than vice versa (Badawy et al., 2019; Finan et al., 2013), perhaps in this population menstrual pain is leading the association. Allyn et al. (2020) did find that several participants reported menstrual pain waking them up in the middle of the night, which may be capturing the acute pain features of menstrual pain, instead of its cyclical pattern. Ultimately, future research should include more participants to assure ample subsample sizes.

Additionally, this study also did not measure or consider other factors that are related to menstrual pain such as NSAID use or consistent physical activity. Research shows that some women do respond well to over-the-counter medications, such as NSAIDs. Further, research has also suggested that some women experience symptoms relief via oral contraceptives. The current study did not find an association between menstrual pain and oral contraceptive use. It might be that women who maintain physical activity are less susceptible to menstrual pain or psychological distress. Research has found that physical activity can greatly reduce menstrual pain (Kannan, Chapple et al., 2019; Kazama et al., 2015; Matthewman et al., 2018; Yonglitthipagon et al., 2017) (see Matthewman et al., 2018 for a discussion). For example, preliminary data suggest that vigorous physical activity can reduce inflammation in the body via progesterone and inflammatory cytokine-mediated mechanisms which result in a reduction of
Menstrual pain (Kannan, Cheung et al., 2019). Future research should examine how physical activity might mitigate menstrual pain or predict differences between menstrual pain subgroups. Including time-varying and time-invariant covariates in GMM after class enumeration may be advantageous. As mentioned earlier, it may be important to consider that with age and childbirth menstrual pain may decrease. Future studies should consider including time-varying or invariant covariates after the class enumeration process has been complete. It is important to first determine the appropriate number of classes before including time-varying or invariant covariates (Frankfurt et al., 2016; Grimm et al., 2016; van de Schoot et al., 2017). Additionally, the current study only utilized three waves of data. Future studies should include more waves of data to better understand the course of dysmenorrhea over time. The current study used data from an ongoing research study. This data should be reanalyzed at the end of the follow-up period to see if results can be replicated with more waves. Further, it would be advantageous to run higher order polynomial models. The spaghetti plots suggest a quadratic model may fit the data better.

**Conclusion**

Menstrual pain is highly prevalent, associated with a number of psychological and behavioral factors, and confers a risk for other chronic pain disorders later in life, such as CPP and CNPP (Li et al., 2020; Tu et al., 2019). Identifying those who might be at higher risk for chronic or worsening menstrual pain is critical. High levels of menstrual pain have been associated with elevated somatic symptoms (Hellman et al., 2020; Payne et al., 2019; Westling et al., 2013; Zuckerman et al., 2018), and this study further demonstrates an association between high levels of somatic symptoms and heightened levels of menstrual pain, beyond the effects of non-menstrual related pelvic pain, anxiety, or depressive symptoms. Further, the relevance of
selected psychological and behavioral predictors of menstrual pain trajectories provided an opportunity to inform the literature of potential tailored interventions by focusing on potentially modifiable psychological and behavioral constructs. Considering these findings, clinicians might consider early intervention for adolescents and women with high levels of somatic symptoms. Additionally, this study confirms prior research findings that suggest menstrual pain is highly variable, and that there are four unique patterns that emerge over time (Ju et al., 2014; Weissman et al., 2004). Future research should continue to examine relations between menstrual pain trajectories and modifiable psychological and behavioral factors to better understand these relations and contribute to possible interventions.
APPENDIX A

DEMOGRAPHIC AND REPRODUCTIVE INFORMATION
1. Date of Birth ________

2. Age (in years) ________

3. Race (Check ALL that apply)
   a. American Indian or Alaska Native
   b. Asian
   c. Native Hawaiian or Pacific Island
   d. Black or African American
   e. White

4. Ethnicity
   a. Hispanic or Latino
   b. NOT Hispanic or Latino

5. What is the highest level of school you completed?
   a. Grade school
   b. Completed High School or GED, or Technical School
   c. Some College
   d. Associate degree
   e. College/Bachelor’s Degree
   f. Post-Graduate Degree

6. Marital Status
   a. Single
   b. Living with partner
   c. Married
   d. Separated
   e. Divorced

7. How many times have you been pregnant?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7
   i. 8
   j. 9
   k. 10 or more
8. What is the total number of children that you have delivered?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7
   i. 8
   j. 9
   k. 10 or more

9. How many times have you given birth vaginally?
   a. 0
   b. 1
   c. 2
   d. 3
   e. 4
   f. 5
   g. 6
   h. 7
   i. 8
   j. 9
   k. 10 or more

10. What method(s) of birth control have you used during the PAST 12 MONTHS? *Please check ALL that apply.*

   a. Abstinence/No male partner in past 12 months
   b. Condoms
   c. Withdrawal (“pulling out”)
   d. Birth Control Pills
   e. Nuva-Ring
   f. Patch (Ortho-Evra)
   g. Depo Proverna
   h. Mirena Hormonal IUD
   i. Copper IUD
   j. Rhythm Method
   k. “Morning after pill”
   l. Sexually active with male partner but did not use contraception
   m. Other
11. Have you used hormonal therapy for or in part to treat menstrual pain IN THE PAST 12 MONTHS? (Yes/No)
APPENDIX B

MENSTRUAL PAIN QUESTIONS
Phone Screen:

1. On a scale of 0-10 with 0 being 'no pain' and 10 being the 'worst pain imaginable', what is your average level of pain during menstruation when NOT TAKING ANY PAINKILLERS?

Screening Visit & Annual Follow Ups:

Please use the slider to indicate the average amount of cramping or pain you have experienced during your menstrual period over the PAST 3 MONTHS when NOT taking any painkillers and on the worst day of your period? The scale is 0 to 100.

---

No Pain 0 Worst pain imaginable 100
APPENDIX C

PAIN CATASTROPHIZING SCALE (PCS)
Everyone experiences painful situations at some point in their lives. Such experiences may include headaches, tooth pain, joint or muscle pain. People are often exposed to situations that may cause pain such as illness, injury, dental procedures or surgery.

We are interested in the types of thoughts and feelings that you have when you are in pain. Listed below are thirteen 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.

When I'm in pain...
1. I worry all the time about whether the pain will end.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

2. I feel I can't go on.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

3. It's terrible and I think it's never going to get any better.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

4. It's awful and I feel that it overwhelms me.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME
5. I feel I can't stand it anymore.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

6. I become afraid that the pain will get worse.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

7. I keep thinking of other painful events.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

8. I anxiously want the pain to go away.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

9. I can't seem to keep it out of my mind.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

10. I keep thinking about how much it hurts.
    a. NOT AT ALL
    b. To a SLIGHT degree
    c. To a MODERATE degree
    d. To a GREAT degree
    e. ALL THE TIME
11. I keep thinking about how badly I want the pain to stop.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

12. There's nothing I can do to reduce the intensity of the pain.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME

13. I wonder whether something serious may happen.
   a. NOT AT ALL
   b. To a SLIGHT degree
   c. To a MODERATE degree
   d. To a GREAT degree
   e. ALL THE TIME
APPENDIX D

BRIEF SENSORY INVENTORY-18; SOMATIZATION SUBSCALE
Below is list of problems people sometimes have. Read each one carefully and circle the number of the response that best describes HOW MUCH THAT PROBLEM HAS DISTRESSED OR BOTHERED YOU DURING THE PAST 7 DAYS INCLUDING TODAY.

0 = Not at all  1 = A little bit  2 = Moderately  3 = Quite a bit  4 = Extremely

1. Faintness or dizziness
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely

2. Pains in heart or chest
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely

3. Nausea or upset stomach
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely

4. Trouble getting your breath
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely

5. Numbness or tingling in parts of your body
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely
6. Feeling weak in parts of your body
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely

7. Trouble with vision
   a. Not at all
   b. A little bit
   c. Moderately
   d. Quite a bit
   e. Extremely
APPENDIX E

NIH PROMIS SLEEP DISTURBANCE SUBSCALE
Please respond to each item by marking one answer per question.

In the past 7 days...

1. My sleep was restless...
   a. Not at all
   b. A little bit
   c. Somewhat
   d. Quite a bit
   e. Very much

2. **I was satisfied with my sleep...
   a. Not at all
   b. A little bit
   c. Somewhat
   d. Quite a bit
   e. Very much

3. **My sleep was refreshing...
   a. Not at all
   b. A little bit
   c. Somewhat
   d. Quite a bit
   e. Very much

4. I had difficulty falling asleep...
   a. Not at all
   b. A little bit
   c. Somewhat
   d. Quite a bit
   e. Very much

5. I had trouble staying asleep...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

6. I had trouble sleeping...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
e. Always

7. **I got enough sleep...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

8. **My sleep quality was…
   a. Very poor
   b. Poor
   c. Fair
   d. Good
   e. Very good
APPENDIX F

NIH PROMIS ANXIETY SUBSCALE
Please respond to each item by marking one answer per question.

In the past 7 days...

1. I felt fearful...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

2. I felt anxious...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

3. I felt worried...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

4. I found it hard to focus on anything other than my anxiety...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

5. I felt nervous...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

6. I felt uneasy...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
e. Always

7. I felt tense…
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
APPENDIX G

NIH PROMIS DEPRESSION SUBSCALE
Please respond to each item by choosing one answer per question.

In the past 7 days...

1. I felt worthless...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

2. I felt that I had nothing to look forward to...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

3. I felt helpless...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

4. I felt sad...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

5. I felt like a failure...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

6. I felt depressed...
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
7. I felt unhappy…
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always

8. I felt hopeless…
   a. Never
   b. Rarely
   c. Sometimes
   d. Often
   e. Always
APPENDIX H

NON-MENSTRUAL RELATED PELVIC PAIN
1. Do you have pelvic, bladder, or abdominal pain that persists outside of your menstrual period? Yes or No
REFERENCE LIST


Brown, T. T., & Lee, W. (2020). The FUTUREPAIN study: Validating a questionnaire to predict the probability of having chronic pain 7-10 years into the future. *PLOS ONE, 15*(8), e0237508. https://doi.org/10.1371/journal.pone.0237508


VITA

Hagy is a doctoral student at Loyola University Chicago studying clinical psychology with a specialty in health psychology and neuropsychology. She received her B.S. in Psychology from The University of North Carolina at Chapel Hill in 2012. During her time as an undergraduate, Hagy conducted research at the Center for Developmental Science examining the impact of parent-child communication. Concurrently, she volunteered for the Youth Identity Project, a longitudinal investigation of the impact of stereotype related to race, gender, and socioeconomic status on youth’s educational outcomes. During her final semester, Hagy gained clinical experience via an internship at the Cape Town Refugee Centre in Cape Town, South Africa, which consisted of family interviews, home visits, coordinating psychosocial interventions, and advocating directly to the United Nations High Commissioner for Refugees on their behalf. After graduation, Hagy worked as a research assistant at Duke University studying cognitive correlates of burnout and depression symptoms. Further exploring her interest in health psychology, Hagy began working at the Masonic Cancer Center at the University of Minnesota-Twin Cities on clinical trials related to women’s cancers (breast and gynecological). She then transitioned to work as the research coordinator for the Human Connectome Aging Project, where she solidified her interest in adult neuropsychology. Since starting graduate school at Loyola, Hagy had been a member of Dr. Amy Bohnert’s research lab and her interest in health psychology continued to grow. As part of this lab, Hagy has worked on projects examining the interrelationship between neuropsychological, psychosocial, psychological, and health behaviors.
in the context of developmental transitions. Hagy’s master’s thesis examined whether there were distinct longitudinal menstrual pain trajectories in a sample of women and the psychological and behavioral predictors of these latent trajectory groups. Collectively, through these aforementioned experiences, Hagy has had the immense privilege of sharing her teams’ innovative research via the dissemination of presentations and peer-reviewed articles.