WEIGHT STATUS AMONG PRESCRIPTION OPIOID USERS WITH CHRONIC PAIN

By

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WEIGHT STATUS AMONG PRESCRIPTION OPIOID USERS WITH CHRONIC PAIN

Abstract

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Background: Greater than 70% of the United States (US) adult population is overweight as defined by body mass index (BMI) greater than 25 kg/m^2. Adults who are overweight are more likely to report chronic pain than those with recommended weight status. Additionally, higher BMI is correlated with poorer pain outcomes. Patients with chronic pain and overweight status report difficulty self-managing pain and weight and are commonly prescribed opioid medications to treat pain. Long-term use of prescription opioids is associated with negative health outcomes, especially among adults with overweight status. Adults with chronic pain report many health symptoms that hinder pain and weight self-management such as poor quality of sleep, high levels of depression, low levels of self-efficacy for symptom management, high levels of pain interference, and high pain intensity. However, the relationships between health symptoms among adults with pain who use prescription opioids remain unclear.

Methods: Using the Individual and Family Self-Management Theory, a secondary analysis of a survey study was conducted to determine relationships between health factors of sleep quality, depression, self-efficacy for symptom management, pain interference, pain intensity, and weight status. The target population was adults ages 18 years and older with self-reported chronic pain taking prescription opioids for either opioid use disorder or chronic pain treatment. Results were analyzed in SPSS software. Regression models were conducted to evaluate relationships.

Study Findings and Implications: The results gained from this investigation identified that weight status is an important consideration in pain interference. Analyzing pain interference as the outcome, it was found that BMI acted as an effect modifier between all health factors and pain interference. Thus, a high BMI significantly increased pain interference in the context of poor sleep quality, high levels of depressive symptoms, and low levels of self-efficacy. Future research efforts should concentrate on developing targeted interventions to help patients with chronic pain manage symptoms through weight self-management. Successful implementation of research-driven interventions may facilitate methods for sustainable weight control and pain self-management which could potentially reduce the need for long-term prescription of opioid medications in this high-risk population.

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CHAPTER ONE

INTRODUCTION

The following chapter outlines two significant health conditions considered to be epidemic among adults in the United States: one, overweight status and two, chronic pain in the context of the use of prescription opioids. The relationship between the two health conditions is summarized and the need for research to address symptom management is provided. Study aims are presented for dissertation research to identify modifiable health factors related to both chronic pain and overweight status among adults prescribed opioid medications.

Statement of the Problem

The prevalence of overweight status in adults has increased significantly in the past four decades within the United States (US) and worldwide (Afshin et al., 2017). Today, more than 39% of adults in the US are classified with a body-mass index (BMI) greater than 30 kg/m^2 (henceforth, the units after BMI will not be listed as is common practice when presenting BMI values), which is the definition of obesity (Hales, Carroll, Fryar, & Ogden, 2017). This is the first time in history that the proportion of adults with obesity surpasses the proportion of adults in the overweight category (BMI between 25-29.9). In total, greater than 70% of the US population is classified as overweight (Centers for Disease Control [CDC], 2017). Hereafter, classification as overweight will refer to persons in both the overweight (BMI between 25-29.9) and obese (BMI > 30) categories. The high proportion of adults classified overweight in the US is alarming. Overweight status has been linked to costly chronic conditions such as cardiac disease and diabetes and has contributed to millions of premature deaths globally in the year 2015 alone (Afshin et al., 2017). Current costs related to health care and loss of workplace productivity for overweight status are estimated at $214.3 billion per year (Finkelstein et al., 2009). Moreover, adults classified as overweight are more likely to report chronic pain, or pain that persists most days for three months or greater (Treede et al., 2015), than adults at recommended weight status (Stone & Broderick, 2012; Wright et al., 2010).

In addition to rising incidence of adults classified as overweight, chronic pain conditions, such as persistent low back pain, are on the rise in the US (Freburger et al., 2009). Chronic pain is frequently treated with opioid medications, yet adults prescribed opioids for chronic pain may continue to report high levels of pain. Poor pain control is a strong predictor of opioid misuse among adults with chronic pain (Weiss et al., 2014). The duration of opioid prescriptions for adults with chronic pain has increased in the past decade in the US, coinciding with steady inclines each year in prescription opioid-related overdoses (Schuchat, Houry, & Guy, 2017). Opioid misuse has been declared an epidemic by the Centers for Disease Control given the increase in hospitalizations and deaths related to opioids (Kolodny et al., 2015), emphasizing the need for better pain control options. Adults with chronic pain classified as overweight suffer more severe pain and higher self-reported pain interference than those at recommended weight status with pain (Ewald, Hurwitz, & Kizhakkeveettil, 2016), which may lead to a response from clinicians to prescribe higher doses of opioids. Furthermore, clinicians receive recommendations to start adults classified as overweight at higher doses of opioid medications due to differing metabolism and clearance of drugs compared to adults with recommended weight status (Yanev &Vlaskovska, 2016). However, adults classified as overweight who take opioid medications are at greater risk for respiratory depression and accidental overdose compared to recommended weight status adults (Schumacher, 2012). Thus, alternative methods are needed to treat symptoms targeted for adults with chronic pain classified as overweight, especially for those prescribed opioids.

Adults with chronic pain classified as overweight often suffer high symptom burden such as presence of depressive symptoms (Allen, Grande, Abernethy, & Currow, 2016), poor eating habits (Vandenkerhof et al., 2011), over-eating (Janke & Kozak, 2012), and poor sleep (Mork et al., 2014). Furthermore, there is evidence that a higher BMI is correlated with greater pain intensity (Chou et al., 2011 & Masheb et al., 2015) and pain interference (Fowler□Brown et al., 2013; McCarthy et al., 2009) among adults with chronic pain when compared to adults with a BMI reflecting recommended weight status. A proposed mechanism for the relationship between weight and pain is that greater weight status places more mechanical stress on the musculoskeletal system, which triggers inflammatory processes that lead to pain and emotional distress (Zdziarski, Wasser, & Vincent, 2015). In contrast, other evidence suggests that chronic pain conditions reduce ability to engage in physical activity which may cause weight gain and subsequent risk for obesity (Narouze & Souzdalnitski, 2015). It is unclear which direction the relationship between chronic pain and overweight status moves in adults, yet the relationship is understood to be complex and multi-factorial (Okifuji & Hare, 2015).

Background and Significance

The prevalence of chronic pain among adults in the US is approximately 21.5% (Nahin, 2015). According to an estimate in the year 2011 by the American Academy of Pain Medicine (2011), 100 million American adults have chronic pain. More recently, the National Institute of Health (NIH) found that over 124 million US adults reported frequent pain within the past three months (Nahin, 2015), meeting criteria for a chronic pain condition. The most common pain condition is chronic low back pain. Low back pain currently afflicts 10.2% of the US adult population which increased from an estimated 3% of the population measured 14 years prior (Freburger et al., 2015). Direct medical costs associated with chronic pain are estimated at $530 billion each year (Dahlhamer et al., 2018). Thus, the issue of chronic pain is highly prevalent and demands improved pain management techniques to reduce costs and human suffering.

Weight loss has been shown to significantly improve pain outcomes among adults with chronic pain classified as overweight (Foy et al., 2011; Kumar, Beavers, Devita, & Messier, 2017; Masheb et al., 2015; Roffey et al., 2011; Shade et al., 2015). Weight loss is therefore beneficial to help mitigate painful conditions, yet often, weight loss through diet and exercise is moderate and not well-sustained over time (Franz et al., 2007). In addition, weight loss is ineffectively attained by adults who report severe pain compared to those with low or mild self-reported pain (Masheb et al., 2015; Ryan et al., 2017), suggesting that alternative approaches are needed to support weight loss among patients suffering from chronic pain. Weight loss through non-traditional methods such as surgical means has been shown to improve pain outcomes among adults with chronic pain (Çakır et al., 2015; Petereit, Jonaitis, Kupčinskas, & Maleckas, 2014). However, bariatric surgeries are associated with risk of surgical complications (Pories, 2008) and furthermore, are typically only indicated for adults who meet criteria for obesity class II and above, defined as BMI ≥ 35 (Obesity Coverage, 2017). Thus, bariatric surgery is not often an option for adults with chronic pain whose BMI falls between 25-35, yet such adults continue to suffer high burden of symptoms related to chronic pain classified as overweight.

Patients report difficulty with simultaneous self-management of pain and weight due to a large number of reported health symptoms (Mauro, Taylor, Wharton, & Sharma, 2007). Furthermore, adults with co-occurring chronic pain and overweight status may perceive that prescribers are hesitant to address both issues at once (Janke et al., 2016). Fragmentation of care and reduced patient health outcomes may occur when providers are unable to holistically approach symptom management of clients with complex co-morbidities. The number of symptoms present coupled with the frustration of patients in self-managing health highlight the need for improved provider-client interactions focused on symptom management. In addition, research is needed to understand relationships between pain symptoms and overweight status in the context of prescription opioid use.

Purpose and Specific Aims

Effective management of symptoms among adults with chronic pain classified as overweight, who are prescribed opioid medications requires better understanding of which modifiable health factors, outside of diet and exercise behaviors, significantly influence the relationship between both health conditions. The main research question driving this dissertation: Among adults who suffer chronic pain and are prescribed opioid medications, what are the relationships between pain intensity, pain interference, depression, sleep quality, self-efficacy for symptom management, and weight status? The purpose of the study was to reveal the relationship between pain outcomes and health factors and to explore the effect of weight status on that relationship. The central hypothesis was weight status significantly impacts the relationship between health factors and pain outcomes among adults with chronic pain who take prescription opioid medications. The rationale for conducting this research was to identify relationships between common symptoms that clinicians can address in adults with co-occurring chronic pain and overweight status to empower adults to engage in both effective pain self-management. See Figure 1.1 below for a figure of the central study hypothesis.

The study aims include:

Aim 1: characterize a sample of adults with chronic pain who take prescription opioids.

Aim 2: determine the relationships between BMI, pain intensity, and pain interference in the sample. *We hypothesize that adults with chronic pain who are prescribed opioids will have* *significantly greater pain intensity and pain interference as BMI increases beyond recommended weight status. We also suspect that the risk for high pain intensity and pain interference is significantly greater among adults classified as overweight compared to adults with recommended weight status.*

Aim 3: test the relationships between health factors of sleep quality, depression, self-efficacy, and BMI and pain outcomes of pain intensity, pain interference in the sample. *We hypothesize that increasing levels of BMI will be related to increasing levels of pain intensity, pain interference, and depression, and decreasing levels of sleep quality and self-efficacy for symptom management among adults with chronic pain who are prescribed opioids.*

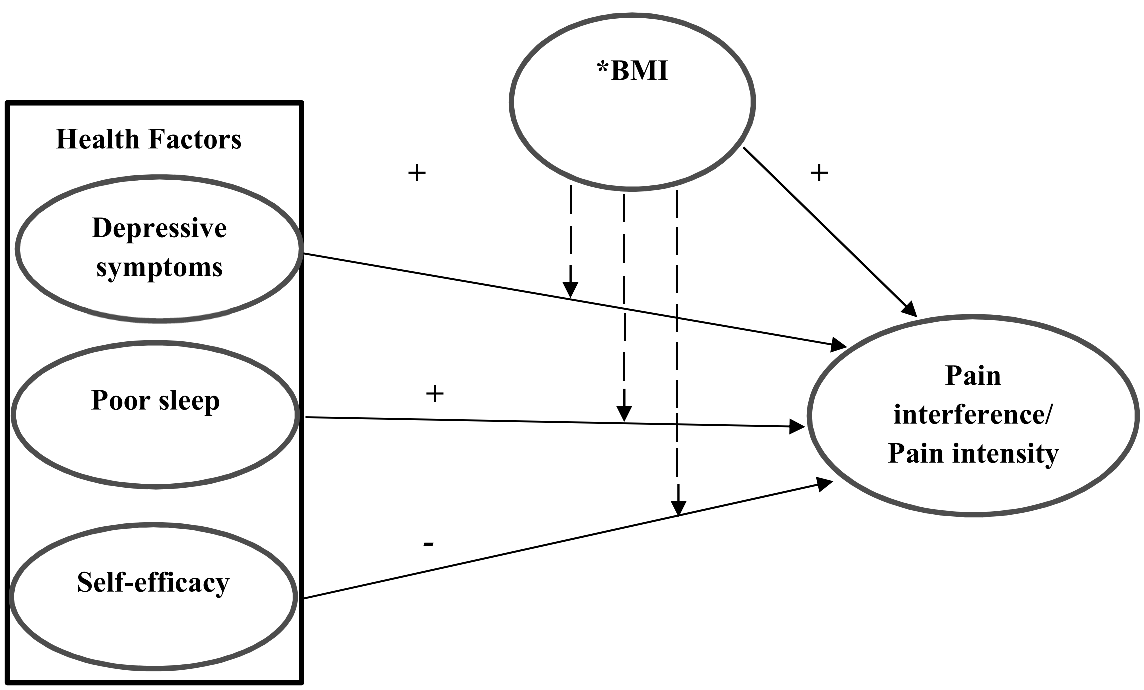

Figure 1.1. Hypothesized impact of BMI on relationships between health factors of depression, sleep quality, and self-efficacy for symptom management and pain measures of pain intensity and pain interference and overweight status.

The results gained from this investigation are expected to identify the relationships between health factors of sleep quality, depression, and self-efficacy for symptom management, and weight status and pain outcomes of pain intensity and pain interference among adults with chronic pain. Specifically, how weight status relates to pain outcomes and other health factors will be tested. Such knowledge will allow clinicians to partner with this population to support targeted symptom management and reduce health risks. As a long-term outcome, treatment options can be created and implemented based on identified health factors to improve sustainable weight-loss strategies and pain outcomes. By identifying how health factors relate to pain outcomes especially in the context of overweight status, alternative or adjunctive chronic pain treatments to opioid use may be revealed. Individualized treatments are anticipated to facilitate positive outcomes to lower costs and disease burden associated with co-occurrence of these conditions among adults with chronic pain who use prescription opioids.

Chapter One Summary

Overweight status (Afshin et al., 2017) and chronic pain (Freburger et al., 2015) are both increasing in prevalence among adults in the US. Both conditions are costly and pose a high risk for poor health outcomes and premature death. Adults with chronic pain are frequently prescribed opioid medications to treat pain, yet the use of opioids is related to opioid misuse, overdose, and death (Schuchat et al., 2017). In addition, adults with overweight status who are prescribed opioids have even greater risk for respiratory depression than adults who are recommended weight status (Schumacher, 2012), demonstrating the danger of using opioid medications in this population. Furthermore, many patients report that providers who treat pain do not address their weight (Janke et al., 2016). While weight loss can improve pain-related outcomes such as pain intensity or pain interference (Kumar et al., 2017; Masheb et al., 2015;

Roffey et al., 2011), traditional diet or exercise interventions may not be feasible for those with high pain levels (Masheb et al., 2015; Ryan et al., 2017). Moreover, surgical weight loss is not indicated for all adults with chronic pain and overweight status (Obesity Coverage, 2017).

Effective disease management and health promotion require better understanding of modifiable health factors that influence pain outcomes. Adults with chronic pain report many health factors that may either hinder or facilitate simultaneous pain and weight self-management. Of these, poor quality of sleep, high levels of depression, low levels of self-efficacy for symptom management, high pain intensity, and high levels of pain interference are burdensome and common in this population. However, the relationships between these factors are unclear among adults using opioid medications for chronic pain. By conducting research to test how weight status relates to health factors and pain outcomes, clinicians will be better informed about how to tailor symptom management among adults in this high-risk population.

CHAPTER TWO

REVIEW OF THE LITERATURE

Among adults with chronic pain, overweight status has been related to worse pain outcomes as well as a higher occurrence of other distressing symptoms when compared to those with recommended weight status. However, it is unknown whether these relationships hold in a population of adults who use prescription opioid medications. This chapter will review current literature outlining the relationship between chronic pain and overweight status among adults, describe the risk for reporting chronic pain among adults with overweight status compared to recommended weight status, detail implications of weight change on chronic pain and related symptoms, provide discussion on the impact of opioid medications on weight status, and present a theoretical framework to address identified gaps in the literature. The chapter will begin with definitions of major constructs vital to this dissertation.

Definitions

The following are definitions for major concepts that are discussed in the following chapters:

Body mass index: weight in kilograms divided by height in meters squared; metric used to determine presence of overweight or obesity (CDC, 2017).

Chronic pain: ongoing or recurrent pain, lasting most days in the past 3 months which negatively impacts health (Treede et al., 2015).

Depression: A presence or increase in symptoms including negative/sad mood, lack of interest in life, lack of energy, suicidal thoughts, change in appetite, or change in sleep lasting more than two weeks (American Psychiatric Association, 2017).

Obese: BMI 30 or greater (Hales et al., 2017).

Opioid Use Disorder (OUD): Patterns of opioid use related to negative health behaviors. Symptoms include withdrawal symptoms upon opioid discontinuation and presence of cravings to use and increase use (American Psychiatric Association, 2013).

Overweight: BMI between 25 -29.9 (CDC, 2017).

Overweight Status: Adult with a BMI greater than 25, thereby encompassing adults with overweight and obesity.

Pain intensity: The perceived degree of pain experienced both at the time of assessment and over a specified timeframe (National Institute of Health [NIH], 2015a).

Pain interference: The extent to which pain has deterred emotional and physical functioning over a specific period, sometimes referred to as pain disability (NIH, 2015b).

Recommended Weight Status: Adults with a BMI between 18.5 – 24.9 (Ogden, 2012).

Self-efficacy for Symptom Management: The belief that one has autonomy to positively control one's own symptoms relating to illness (Ryan & Sawin, 2009).

Sleep quality: An individual's perception of ability to obtain restful, consistent sleep over time (Buysse et al., 1988).

Risk for Chronic Pain Among Adults with Overweight Status

Both chronic pain and overweight status are major public health concerns in the United States today. National objectives relating to improving pain and weight outcomes are written in "Healthy People 2020" and include reducing the number of adults who are considered obese, reducing activity limitations and pain levels among adults with a pain condition diagnosed by a licensed health care professional, and decreasing non-medical use of prescription pain relievers (US Department of Health and Human Services, 2014). There is evidence of a significant link between overweight status and chronic pain conditions (Narouze & Souzdalnitski, 2015) and that weight reduction may improve pain outcomes among adults with chronic pain (Çakır et al., 2015; Kumar et al., 2017; Masheb et al., 2015; Roffey et al., 2011). Obesity is a known risk factor for chronic musculoskeletal pain such as back pain. An analysis conducted among 25,450 adults in Norway found that prior obesity status significantly predicted incidence and recurrence of chronic low back pain at follow-up of 11 years among both men and women after adjusting for demographics, metabolic risk factors, and other lifestyle risk factors such as smoking (Heuch, Heuch, Hagen, & Zwart, 2013). Furthermore, a recent meta-analysis found that the pooled odds ratio for new incidence of low back pain among more than 50,000 adults was 1.33 (95% CI 1.14-1.54) and the odds ratio for existing chronic low back pain was 1.43 (95% CI 1.28-1.60) among adults with obesity compared to recommended weight status (Shiri et al., 2010). An analysis of prevalence reports of low back pain and overweight status across nine countries worldwide revealed a significant association between reports of chronic pain and obesity, though the strength of the association varied by country (Koyanagi et al., 2015). A proposed mechanism of association between obesity and joint-related pain is that the increased weight on joints from overweight and obese status can cause biomechanical, inflammatory, and structural damage to cartilage and bone which results in pain (Zdziarski et al., 2015).

Emerging evidence suggests that obesity is also related to non-joint-related chronic pain such as headache (Wright et al., 2010) or chronic wide-spread pain (Mundal et al., 2014). A small cross-sectional study among 44 Japanese adults with non-muscular neuropathic pain found that pain intensity and total number of pain symptoms were higher among adults with an obese BMI versus a recommended BMI (Hozumi et al., 2017). In Germany, it was found that obesity was associated with self-reported neuropathic pain and higher pain intensity and severity but not non-neuropathic pain among more than 3,000 adults surveyed (Ohayon & Stingl, 2012). Thus, it appears that the mechanisms underlying the link between chronic pain and obesity are multifactorial and complex (Narouze & Souzdalnitski, 2015).

Several population studies throughout countries around the world have been conducted to explore the risk of reporting any type of chronic pain among overweight and obese adults as compared to adults who are recommended weight status. A literature review examined population studies worldwide conducted from the years 2000 – 2017 to calculate unadjusted risk and odds ratios for presence of chronic pain among adults with overweight status defined as BMI ≥ 25 compared to adults with recommended weight status of BMI < 25 (Bigand, Wilson, Bindler, & Daratha, 2018). Table 2.1 below summarizes odds and risk ratios calculated from eight studies that met criteria from the literature review. This was important knowledge because the review found that risk for reports of chronic pain were greater among adults who met criteria for overweight including obesity when compared to recommended weight status in samples from North America, South America, Western and Central Europe, and Australia. This finding suggests that adults who meet criteria for overweight status may benefit from support on self-management of weight to reduce risk for reports of chronic pain as well as adults who meet criteria for obesity (Bigand et al., 2018). However, the studies analyzed in the review did not consider the relationship between chronic pain and other health factors in the context of opioid versus non-opioid medication use. The relationships between chronic pain and health factors among adults with chronic pain in the context of prescription opioid use remains unclear, especially in the context of overweight status.

Table 2.1.
Relative Risk and Odds Ratios for Chronic Pain among Adults with Overweight Versus Recommended Weight

Study Author and Year	**Chronic Pain Definition**	**Prevalence overweight status among adults with pain**	**Relative Risk**	**Odds Ratio**	**Total Sample Size**	**Chi-square value**
Heuch et al., 2013	National health questionnaire (presence of **low back** pain last 3 continuous months in previous year)	Time #2 of the longitudinal study: 4349/6848 = 64%	1.14	1.20	24,450	$p < 0.001$
Fowler-Brown et al., 2013	Brief Pain Inventory and Joint Pain Questionnaire (pain in joints or all over on most days for past three months or more)	249/330 = 75%	1.41	1.80	736	$p < 0.001$
McCarthy et al., 2009	Total Pain Index (moderate pain, >3/10, lasting greater than 3 months)	273/424 = 64%	1.21	1.48	819	$p < 0.01$
Allen et al., 2016	South Australian Health Omnibus Survey (pain lasting 3 of the past 6 months)	402/644 = 63%	1.41	1.56	2616	$p < 0.001$
Jakobsson, 2010	Survey (pain in last three months or more)	155/309 = 50%	1.17	1.29	826	$p = 0.08$

Vandenkerkhof et al., 2000	Survey (**widespread pain** in last three months per Fibromyalgia definition)	Time #2 of the longitudinal study: 455/909 = 50%	1.45	1.03	6948	$p <$ 0.001
Lake et al., 2000	Questions from validated survey (pain in **low back** lasting three or more months)	409/1021 = 40%*	1.15	1.17	9134	$p = 0.02$
Ohayon et al., 2012	Phone survey (pain lasting three months or greater)	352/752 = 47%	1.44	1.20	3011	$p = 0.03$
Gouveia et al., 2016	Self-report (presence of **low-back** pain in past 90+ days)	941/1346= 70%	1.71	1.86	4091	$p <$ 0.001

Many factors have been identified in the literature that relate to the co-occurrence of chronic pain and overweight status. Some of these factors may not be modifiable such as the timing of prior overweight status influencing future incidence of chronic pain, age, genetics, and gender. Other identified factors are potentially modifiable and include lifestyle behaviors such as diet and physical activity, health conditions such as depressed mood and sleep quality, symptoms such as pain intensity and pain interference, and confidence in disease management defined as self-efficacy for symptom management. The latter modifiable health factors are explored for the purpose of the study at hand because they are involved in the pain experience as measured by pain intensity and pain interference constructs. All non-modifiable and modifiable factors will be detailed in the discussion below with supporting evidence from the literature. Following this discussion, the limitations of knowledge about how relationships between modifiable health factors and pain outcomes change in the context of overweight status among adults with chronic pain who use opioid medications will be detailed.

Timing Influences Relationship between Pain and Overweight. A question raised by recent reviews into the association of pain and weight status are whether increased BMI predisposes to chronic pain, chronic pain predisposes to overweight status, or whether the two conditions occur in concert (Narouze & Souzdalnitski, 2015). A longitudinal study using data from more than 25,000 European adults demonstrated no significant increase in body weight among those with chronic pain at baseline during the ten-year follow-up, yet there was a significant association between overweight status at baseline and presence of chronic pain (Heuch et al., 2013). Further evidence exhibited that women who had overweight status at age 23 had significantly greater odds ratio of development of chronic low back pain at age 33 and gained a statistically significant average weight of 1.1 kg (2.42 pounds) more than females with recommended weight status over an 11-year follow-up (Lake, Power, & Cole, 2000). Men had similar risks, though calculated values did not achieve statistical significance. Although the sample with pain at baseline did gain more weight at follow-up than those without pain, the number is clinically insignificant at only 2.42 lb. more than the group denying pain at baseline (Lake et al., 2000). Both studies indicate that baseline overweight status is more clinically significant in predicting future incidence of chronic pain complaints than baseline chronic pain status is in driving overweight status. Thus, prevention of overweight status may reduce the number of adults with future incidence of pain complaints.

Age Influences Relationship between Pain and Overweight. Evidence suggests that among older adults, as weight increases above recommended status, reports of pain are more likely to be present. Fowler-Brown and colleagues (2013) analyzed data from 736 adults ages 65 and older and found that especially for women, obesity was associated with a greater risk for complaints of disability related to pain, and this relationship was strengthened by the number of pain locations reported. In addition, Stone and Broderick (2012), found that among over 1 million adults in the United States, reports of co-occurring chronic pain and overweight status were more prevalent as age increased with the strongest association noted for the age group of 40 years and older when controlling for other demographic factors. Similarly, among adults aged 70 and older, the presence of pain anywhere on the body is explained by BMI and central obesity but not by other markers of metabolic syndrome (Ray et al., 2010). Furthermore, among adults aged 70 years and older, odds of reporting of chronic pain increased in a dose-dependent manner as BMI increased (McCarthy et al., 2009).

Co-occurring pain and overweight status has been observed to peak in the 55-74 year old age group (Allen et al., 2016). This finding is synomomous with evidence that prevalence of both chronic pain conditions and obesity increase with age; chronic pain is more frequently reported among adults 45 years and older than adults 44 years and younger (Nahin, 2015) and obesity is most prevalent in the 45-64 years age group in the US (Hales et al., 2017). While increasing age strengthens the relationship between overweight status and presence of chronic pain in adults, the association appears to remains significant across all adult age groups (Stone & Broderick, 2012). It is unclear, however, whether the use of opioid medications changes how age impacts the relationship between chronic pain and overweight status.

Gender Influences Relationship between Pain and Overweight. Several studies find that female gender is more strongly associated with co-occurring overweight status and chronic pain in adults than male gender. Lake and researchers (2000), for example, were only able to demonstrate a significant relationship between weight status and low back pain among women in their longitudinal cohort study of more than 11,000 adults. In contrast, a more recent longitudinal study of over 25,000 adults demonstrated that BMI at baseline was related to new onset and recurrence of low back pain at follow-up 11-13 years later in both males and females, though the relationship was stronger among females (Heuch et al., 2013). Furthermore, Australian men with increasing BMI and other measures of weight status such as fat mass and waist hip ratio were found to have higher risk for reports of chronic pain (Chou et al., 2016). Among both men and women, the odds of reporting chronic widespread pain at 45 years old was much greater if at age 33 years there were reports of elevated BMI, though this relationship was stronger for females (Vandenkerkhof et al., 2011). Thus, it appears that female gender is more strongly related to co-occurring chronic pain and overweight status than male gender, though higher risk for chronic pain has been observed among both sexes when also suffering from overweight status. Still, it is not known whether the impact of gender on the relationship between chronic pain and overweight status remains the same in the context of regular prescription opioid use.

Genetics Influence Relationship between Pain and Overweight. Genetics have been demonstrated to play a role in the relationship between chronic pain and overweight status. For example, among over 2,000 twin pairs, there was found to be an increased risk for reports of chronic pain in a dose-dependent direction with BMI compared to twin pairs of recommended weight status (Wright et al., 2010). Environmental factors are also believed to influence pain and overweight status. Data from a large longitudinal study including 4,742 parent-offspring trios collected from the years 1995-1997 and the years 2006-2008 were analyzed to explore whether parental overweight and chronic pain status were predictors for development of chronic musculoskeletal pain and overweight status among adult offspring (Lier et al., 2016). At baseline, adult offspring with overweight status and with parents who reported chronic pain had a dose-dependent risk of developing chronic pain at follow-up based on BMI as compared to adults with recommended weight status whose parents were pain-free at baseline. There was no significant impact on offspring pain levels at follow-up if parental BMI was elevated at baseline. (Lier et al., 2016). A dose-dependent relationship between chronic low back pain and BMI was identified in a systematic review consisting of 11 studies among adults where the relationship was weakened in the presence of genetics and familial factors (Dario et al., 2015). The weakened relationship suggests a significant impact of epigenetics on risk for low back pain among adults with overweight status. These findings lend credibility to the genetic mechanisms underlying the relationship between overweight status and chronic pain, though it is unknown whether these relationships are maintained among regular prescription opioid users.

Lifestyle Influences Relationship between Pain and Overweight. Lifestyle factors of diet and exercise play an important role in the relationship between overweight status and pain conditions. As BMI increases among women, reports of regular exercise and fruit and vegetable intake have been observed to decrease (Knerr, Bowen, Beresford, & Wang, 2016). In addition, children who report low levels of physical activity and whose parents report pain are more likely to report chronic pain later in life than adult children who report high levels of physical activity and have pain-free parents (Lier et al., 2016). Women have been found to be more likely to complain of chronic widespread pain at age 45 years if they reported eating less fruits and vegetables and more fatty foods and chips at age 33 years than women who reported eating more fruits and vegetables and less fatty foods at the same age (Vandenkerkhof et al., 2011). This association is less clear for men, whose diets have been observed to be less healthy than women's and to not vary greatly with time. For both men and women, the odds of reporting chronic widespread pain at 45 years old is statistically significantly greater if at age 33 years there were reports of elevated BMI. No significant relationship was observed in the latter longitudinal study between physical activity levels reported at age 33 years and 43 years and chronic widespread pain reports at age 45 years (Vandenkerkhof et al., 2011).

Adults with chronic pain and overweight status have reported low levels of physical activity and diets high in fat, sugar, and sodium to cope with discomfort (Janke & Kozak, 2012). Moreover, Melenger and colleagues (2014) studied the diets of adults with chronic pain and showed that nearly half of the sample of 50 adults met criteria for obesity and that participants were deficient in vitamins D and E, ate on average significantly less than the national guidelines for 5 servings per day of fruits and vegetables, and over-consumed sodium, added sugars, fats, caffeine, and total daily calories. Collectively, these findings suggest that a poor diet and physical activity levels may coincide with chronic pain conditions.

Lifestyle interventions including diet and exercise have been proposed to be helpful to reduce pain and weight among adults with chronic pain and overweight status. However, weight loss outcomes may be difficult to attain and maintain over time. A meta-analysis comparing 80 intervention studies focusing on diet and exercise to reduce overweight status among adults found that on average, weight loss peaked after 6 months at 4.8% - 8% of initial body weight and that after 48 months of follow-up, weight had increased but was still 3% - 4% below baseline body weight (Franz et al., 2008). Weight loss interventions may be even more challenging to implement among adults with co-occurring chronic pain and overweight status. For example, psychosocial factors such as pain catastrophizing and perceived disability related to pain have been observed to negatively impact ability of adults with chronic pain to engage in physical activity for weight loss (Vincent et al., 2014). Furthermore, weight loss focused on lifestyle interventions are blunted among adults with chronic pain and overweight status who report high levels of pain (Masheb et al., 2015; Ryan et al., 2017). Such findings suggest the need for alternative approaches to manage co-occurring chronic pain and overweight status, specifically among adults who regularly use prescription opioids.

Depressed Mood Influences Relationship between Pain and Overweight. There is robust evidence that a depressed mood influences both chronic pain and overweight status as separate and co-occurring conditions. With regards to pain outcomes, for example, it was found that presence of depressive symptoms was the most significant correlate of self-reported back pain across more than 42,000 participants and 9 countries worldwide (Koyanagi et al., 2015). Furthermore, among more than 144,000 adults in the United Kingdom, current depressive symptoms were dose-dependently associated with an increase in the number of reported pain sites (Nicholl et al., 2015). Recurrence of chronic widespread pain among 25,000 adults in Europe was predicted by mixed anxiety and depressive symptoms (Mundal et al., 2014). Similarly, depression has been shown to influence pain intensity and pain interference outcomes, and among adults who have suffered a longer duration of diagnosis, the role of depression is more influential in explaining this link (Probst et al., 2016). Thus, it is accepted that depression impacts the pain experience among adults with chronic pain.

Depressive symptoms are also related to overweight status among adults. A meta-analysis pooling data from more than 200,000 adults world-wide found an overall odds ratio of 1.26 (95% CI: 1.17–1.36, $P \leq 0.001$) for reporting depression among adults with BMI ≥ 30 compared to BMI < 30, though this was more strongly associated with female gender (deWit et al., 2010). Thus, there is strong evidence that obesity and depressive symptoms are related.

Depressed mood is related to co-occurring chronic pain and overweight status. For instance, depressive symptoms and feelings of guilt and shame about inability to self-manage pain and weight conditions have been reported as common experiences by adults with co-occurring chronic pain and overweight status (Janke & Kozak, 2012). In addition, when exploring the relationship between overweight status and chronic pain reported among twins, self-reported depression weakened the relationship, suggesting that depression influences the relationship between the two conditions (Wright et al., 2010). Furthermore, among 372 adults with chronic pain, it was found that as BMI increased, there was a statistically significant increase in depression rates though no significant changes were noted in anxiety among the different weight categories (Marcus, 2004). Similarly, across 394 adults with overweight status and chronic pain who participated in a weight-loss intervention study, those who reported depressive symptoms had a higher risk of reporting moderate to severe pain than those without (Masheb et al., 2015).

Pain outcomes are also impacted by depressed mood in the context of overweight status. Higher frequency of migraine episodes and higher pain interference was observed among adults with migraine headaches who also had overweight status and depressive symptoms as compared to adults with recommended weight status and absence of depression (Tietjen et al., 2007). Thus, depressive symptoms may influence poorer health outcomes among adults who have overweight status and chronic pain compared to those who are recommended weight status, yet there is little evidence examining how overweight status specifically changes relationships between depression and pain outcomes among a population who regularly uses prescription opioids.

Self-Efficacy Influences Relationship between Pain and Overweight. Weight status is related to self-efficacy among adults. For example, self-efficacy for weight management was measured among 487 women and was found to be inversely related to BMI (Knerr et al., 2016). Furthermore, self-efficacy may impact pain outcomes among adults with chronic pain. For instance, higher self-efficacy was shown to be associated with better health outcomes such as higher sleep quality and lower pain intensity among adults with sickle cell anemia, a type of chronic pain disorder (Adegbola, 2015). Moreover, an intervention study conducted by researchers on 120 adults with chronic wide-spread pain, found that high levels of self-efficacy for pain management predicted improvement in pain outcomes 6 to 18 months after a cognitive behavioral intervention provided by pain clinicians (De Rooij et al., 2013). Thus, self-efficacy may impact overweight status as well as chronic pain outcomes.

Self-efficacy also plays a role in co-occurring chronic pain and overweight status in adults. A qualitative interview of 30 adults with chronic pain conditions and overweight status was conducted, and a major theme from participant reports was that poor self-efficacy for managing weight and pain was a contributor to the co-morbid conditions (Janke & Kozak, 2012). In addition, higher levels of self-efficacy have been found to be associated with lower levels of pain among adults with chronic pain and overweight status (Pells et al., 2008). Moreover, a randomized-controlled trial with more than 200 adults found that a 6-month weight-loss intervention combined with a psychological pain coping intervention improved self-efficacy scores significantly more than weight-loss alone, pain coping education alone, or treatment as usual groups (Somers et al., 2012). Thus, self-efficacy influences weight and pain self-management among adults with chronic pain, yet little is known about how self-efficacy relates to pain outcomes in the context of overweight status and regular use of prescription opioids.

Sleep Influences Relationship between Pain and Overweight. Poor sleep quality impacts co-occurring chronic pain and overweight conditions (Mork et al., 2013). When looking specifically at populations of adults with overweight status, a meta-analysis pooling global data from over 600,000 adults found that obesity was associated with increased odds of 1.55 (95% CI

1.43-1.68) of reporting sleep duration of either <5 hours or <7 hours per night compared to adults of recommended weight status (Cappucio et al., 2008). Similarly, poor sleep quality is reported as a prevalent symptom associated with worsened pain outcomes among adults with chronic pain (Campbell et al., 2013).

Poor sleep quality has been found to be a common symptom among adults with co-occurring chronic pain and overweight status. For example, among adults with fibromyalgia it has been demonstrated that obesity was associated with shorter sleep duration and greater restlessness during sleep (Okifuji et al., 2010). In addition, across more than 28,000 adults, it was observed that recurrence of chronic widespread pain at 11-year follow-up was strongly predicted by presence of self-reported sleep problems at baseline (Mundal et al., 2014). Similarly, in a study including 26,896 adults, stratified analyses found that adults with obesity compared to recommend weight status who reported with sleep problems “sometimes” at baseline were more likely to complain of back and neck pain “sometimes” or “often/always” at 11-year follow-up (Mork et al., 2013). Thus, poor sleep may predict future development of pain, and this relationship may be influenced by overweight status.

Research suggests that weight loss may improve sleep among adults with chronic pain and overweight status. For instance, in a weight loss trial including more than 200 women with overweight and obese status, those who achieved greater than 5% weight loss at the end of the 6-month intervention had significantly improved sleep disturbance and pain interference scores compared to those who lost less weight (Shade et al., 2016). More knowledge is needed about how sleep quality and pain outcomes are impacted by overweight status among adults with chronic pain who use prescription opioids.

Pain measures influenced by overweight status. Two major markers of the degree of the pain experience within a population suffering chronic pain conditions are pain intensity and pain interference (Younger, McCue, & Mackey, 2009). Both outcomes are highly inter-correlated (Haefeli & Elfering, 2006). It has been suggested that the two measures should be assessed together in adults with chronic pain to more holistically capture the concept of the pain experience (Wilson, 2014). Pain intensity is defined as the degree of pain experienced by an individual in a given time frame and is often thought of as a unidimensional measure (Younger et al., 2009). Pain interference involves the extent to which pain precludes ability to attain optimal emotional, social, and physical functioning (Haefeli & Elfering, 2006). The concept of pain interference encompasses many dimensions of the pain experience including mood, sleep, physical activity, and social interactions (NIH, 2015b). Thus, for the proposed study at hand, it is logical to test the impact of the health factors of sleep quality, depression, and self-efficacy for symptom management on the relationship between chronic pain and overweight status using both pain intensity and pain interference to capture the pain experience in adults who regularly use prescription opioids.

Research suggests that pain intensity and pain interference are experienced differently based on weight status among adults with chronic pain. Some evidence suggests that BMI is related to pain intensity and pain interference in a dose-dependent relationship among adults with chronic pain who are overweight status. The discussion that follows will detail findings of self-reported pain intensity and pain interference stratified by adult weight status.

Pain interference. Several studies find an association between pain interference and overweight status among adults with chronic pain. Allen and researchers (2016) found that having an obese BMI and presence of chronic pain were related to increase in self-reported moderate-to-severe pain interference with day-to-day activities among adult males (OR 2.25; 95 % CI 1.57-3.23; $p < 0.001$). Among a sample of 62 adults with the painful condition of sickle cell anemia, weight status was found to be statistically significantly associated with pain interference (Pells et al., 2005). Australian males who reported high pain interference had significantly higher BMI and waist-hip ratio than those with low or no self-reported pain or disability (Chou et al., 2016). Obesity has been found to be associated with poorer self-reported physical functioning among both genders (Fowler□Brown et al., 2013). Furthermore, it was demonstrated that as BMI increased among adults with chronic pain, there was a statistically significant increase in number of days per week of reported inability to perform daily activities (Marcus, 2004) as well as higher pain interference levels (Urquhart et al., 2011). Thus, presence of overweight status appears to worsen pain interference outcomes among adults with chronic pain, highlighting the need for better weight control options for this population.

Pain intensity. Evidence exists to support the relationship between high pain intensity and overweight status. Okifuji and researchers (2010) found that adults with obesity had statistically significantly higher pain intensity ratings compared to normal-weight participants in a sample of 215 adults with fibromyalgia. Two separate studies in Australia also showed that adults with overweight or obese BMI had higher reports of pain intensity than adults with recommended weight status (Chou et al., 2016; Urquhart et al., 2011). Thus, among populations of adults with chronic pain, overweight status has been found to be related to the pain measure of pain intensity, though studies have not focused on adults using prescription opioids.

Conversely, some studies were unable to find a significant relationship between pain intensity and BMI. Fowler-Brown and colleagues (2013) conducted a study which found that obesity was not significantly associated with pain intensity for either gender (Fowler□Brown et al., 2013). Results from a study conducted by Marcus (2004) showed no significant difference in pain severity measured on a scale of 0-10 among weight groups. Pells and investigators (2005) analyzed data from 62 adults with sickle cell anemia and found that overweight status was not statistically significantly associated with pain intensity rated on a scale of 0-10. Thus, it appears that when using a unidimensional pain scale to measure pain intensity, no statistically significant relationship between chronic pain and overweight status is detected, though it is unclear whether the use of other validated, reliable measures of pain intensity may reveal a relationship, particularly if assessing a population of adults with chronic pain using prescription opioids.

Impact of Weight Change on Adults with Chronic Pain and Overweight

Changes in weight can impact pain outcomes for adults with chronic pain and overweight status. The discussion below examines studies supporting this relationship.

Pain interference and weight change through lifestyle. Several weight-loss interventions conducted among adults with chronic pain conditions lend evidence to the relationship between pain interference and overweight status. For instance, Luis Román and colleagues (2012) found that after 3 months of intensive dietary intervention among 55 Spanish adults with osteoarthritis and obesity, there was a statistically significant improvement on the Western Ontario and McMaster Osteoarthritis Universities Index (WOMAC), a reliable and valid measure of pain interference. Similarly, in a randomized-controlled trial involving more than 2,000 adults with knee pain, diet and lifestyle changes resulted in an average of 19 lb. greater weight loss than education on weight loss alone, and this weight loss was associated with significantly improved pain interference scores (Foy et al., 2011). Moreover, Messier and colleagues (2013) conducted a study among 399 adults with arthritis in the US in which participants were randomly assigned to either an intensive exercise group, an intensive diet group, or an exercise plus diet intervention group. Researchers demonstrated a statistically significant decrease in pain interference on average among the individuals who lost the most amount of weight compared to the least amount regardless of intervention (Messier et al., 2013). Thus, weight loss through diet and exercise can improve pain interference outcomes among adults with chronic pain, though more evidence is needed to understand if this relationship is the same among adults who regularly use prescribed opioid medications.

Beyond lifestyle weight-loss interventions, improving coping skills may also improve pain and weight-loss outcomes in this population. A study involving 232 adults with knee osteoarthritis and overweight or obesity found that those who combined weight loss with a pain coping skills intervention had significantly lower pain interference from baseline to follow-up 6 months later compared to weight loss only, pain coping teaching only, and treatment as usual (Somers et al., 2012). Thus, diet and lifestyle interventions may enhance pain outcomes when paired with psychosocial interventions aimed at improving co-occurring symptoms of poor self-efficacy or depressed mood, though the relationship needs to be explored among adults who use prescription opioids for pain.

Weight gain was found to have adverse effects on pain interference among adults with chronic pain. Tanamas and colleagues (2013) performed baseline assessment data and follow-up after two years on 196 Australian adults with and without osteoarthritis recruited from acute care settings and weight loss clinics. Accurate height and weight were measured at each point, and BMI was calculated to track the changes in weight status over the two-year period. At follow-up, those who gained weight above baseline scored significantly worse on a pain interference measure as compared to the weight-stable group. Additionally, those who lost weight from baseline performed better on pain and stiffness scores as compared to the weight-stable groups

(Tanamas et al., 2013). These results lend credit to the notion that weight loss could be a preventive measure in decreasing pain interference among adults who are overweight or obese and conversely, that weight gain may negatively impact pain outcomes, though more evidence is needed to support this relationship among adults who regularly take prescription opioids.

Pain intensity and weight change through lifestyle. Weight loss through conventional means has been found to have a significant impact on pain intensity levels among adults with chronic pain. Messier and colleagues (2013) conducted a study among 399 adults with arthritis in the US. Participants were randomly assigned to either an intensive exercise group, an intensive diet group, or an exercise plus diet intervention group during the 18-month intervention. Researchers demonstrated statistically significant decreases in pain intensity for diet and exercise groups, and a decrease in pain intensity on average among the individuals who lost the most amount of weight compared to the least amount regardless of intervention (Messier et al., 2013). Pain intensity levels were significantly improved among 232 US adults with knee osteoarthritis who participated in a 6-month exercise and nutrition intervention coupled with psychological pain coping information sessions, showing again that weight loss interventions may be enhanced by addressing psychosocial symptoms of pain (Somers et al., 2012). Additionally, a randomized-controlled trial found that among 49 adults with chronic low back pain, those who engaged in regular total body resistance exercise for four months had significantly reduced self-reported pain intensity and decreased the amount of regular pain medication taken compared to the treatment-as-usual group (Vincent et al., 2014). Although the type of pain medication was not explicitly described as opioids in the latter study, this finding suggests that adults may treat pain and weight outcomes through approaches other than opioids.

Weight loss has been noted to be adversely affected by high pain intensity levels. Masheb and colleagues (2015) analyzed data from 481 US adult veterans who participated in diet and exercise weight loss interventions and found that those reported the highest pain severity lost the least amount of weight as compared to those who reported low or no pain. No difference in weight loss was noted among pain diagnoses, suggesting a more important relationship between pain intensity and ability to lose weight (Masheb et al., 2015). Similar results were seen in a longitudinal study in England where obese participants with severe pain lost on average 11 pounds less than comparison groups who reported mild to moderate pain (Ryan et al., 2017). Thus, severe pain intensity may be a significant barrier to weight loss using traditional lifestyle approaches. It is unknown how the use of opioid medications impact pain intensity levels and thus influence weight loss among adults with chronic pain and overweight status.

Pain outcomes and bariatric surgery. Weight loss through non-conventional means of bariatric surgery have demonstrated favorable improvements in pain intensity and pain interference among adults with chronic pain. Çakır and colleagues (2015) exhibited statistically significant decreases in pain intensity measured by a visual analogue scale 6 months after bariatric surgery-induced weight loss (Çakır et al., 2015). Similar results were seen in a study involving 38 patients with reductions in self-reported back pain and interference at the one-year follow-up time point (Khouier et al., 2009). Painful gastrointestinal (GI) symptoms were also significantly improved among 177 morbidly obese Lithuanian patients one year after Roux-en-Y gastric bypass (Petereit et al., 2014). To measure the presence or absence of back pain in response to weight loss, 400 adults were retrospectively examined after gastric bypass surgery where pre-operatively, mean BMI was 48 and 65% of the sample reported low back pain (Peluso & Vanek, 2007). Follow-up averaged 12.8 months after surgery, and mean percent estimated body weight loss was 73% at the two-year mark. Overall, 75% of the sample reported either improvement or resolution of back symptoms, and of those regularly taking medications to treat the pain prior to surgery, less than half continued to do so at follow-up (Peluso & Vanek, 2007), though it was not specified whether the pain medications included opioids. Notwithstanding, these findings lend evidence to the potential for effective treatment of chronic pain through surgical weight loss for adults with overweight status and pain which may allow for a subsequent reduction or omission of the need for use of medications to manage pain.

The question of the differences in pain outcomes related to surgical versus conventional weight loss was approached by a group of researchers in Sweden (Peltonen, Lindroos, & Torgerson, 2003). Compared to controls who lost weight through exercise and dietary interventions, obese adults who underwent bariatric surgery lost more weight, reported less pain, and reported less incidence of joint pain restricting their work abilities. However, when the data were pooled, greater percentage weight loss appeared to be the strongest factor influencing the improvement in pain and functioning outcomes as opposed to the weight-loss approach (Peltonen et al., 2003). Thus, weight loss through any method may help reduce pain intensity and pain interference associated with obesity, demonstrating the need for sustainable weight, pain, and symptom management in this population, though more research is needed to define these relationships among adults who regularly use opioid medications.

Opioids and Weight Status

The relationship between chronic pain and overweight status appears to be well-established in many populations worldwide. However, to the knowledge of this author, this relationship has not been explicitly explored among adults who take prescription opioid medications. Adults are prescribed opioid medications for two major reasons: to manage painful conditions (Dowell, Haegerich, & Chou 2016) and to manage opioid use disorders (Fullerton et al., 2014). The prevalence of chronic pain among populations of adults in treatment for opioid use disorder has been documented as approximately 65%, with more than half of adults in treatment reporting that a chronic pain condition precipitated opioid use disorder (Hser et al., 2017). Therefore, chronic pain is an issue in both populations. Prescription use of opioid medications has been declared an epidemic in the United States due to rising numbers of opioid-related fatalities (Kolodny et al., 2015). An estimated 63,000 deaths were attributed to an opioid overdose in the year 2016, and evidence remains unclear whether overdoses are accidental or result of suicide attempts (Drug Enforcement Administration, 2018). Thus, alternative pain management strategies are of national priority to alleviate the high symptom burden and potential for harm among adults with chronic pain regularly using prescription opioids.

Prescription opioid medication is widely used as treatment for chronic pain disorders and for opioid use disorder. However, the long-term use of opioid medications for chronic pain has been associated with adverse outcomes such as opioid use disorder, overdose potentially leading to premature death, car accidents, and cardiovascular events (Dowell et al., 2016). Of concern is that due to differing metabolism and clearance of drugs for adults with overweight status compared to recommended weight status, clinicians have been recommended to start adults with obesity at higher doses of opioid medications (Yanev &Vlaskovska, 2016). Furthermore, prevalence estimates suggest that among adult veterans in the US, those prescribed opioid medications for chronic pain had a higher average BMI than those who were not prescribed opioids (Morasco et al., 2010). In Australia, 67% of surveyed adults with obesity were estimated to be taking prescription opioids (Rogers, Kemp, McLachlan, & Blyth, 2013). Thus, prescription opioids are common among adults with overweight status and chronic pain, though the impact of co-occurring health symptoms such as sleep quality, depressed mood, and self-efficacy on the relationship between chronic pain and overweight status in the context of regular prescription opioid use is not explicitly known.

Several adverse health effects of taking opioids have been linked to overweight status. For example, a recent cross-sectional study in the United Kingdon found that adults taking medications for cardiac disease such as high cholesterol or hypertension who also took opioids had significantly greater odds for having an overweight BMI, very high risk waist circumference, and high blood pressure than adults only taking meds for cardiac disease (Cassidy, Trenall, & Anderson, 2017). Furthermore, a randomized-controlled, single-blind trial demonstrated that among more than 200 adults from the Veterans Association with chronic pain who were prescribed either an opioid medication or a non-opioid pain medication for 12 months, pain intensity and pain interference measures were better and adverse medication effects were lower in the group prescribed non-opioid medications compared to those prescribed opioids (Krebs et al., 2018). Adults with overweight status are also high-risk for suffering obstructive sleep apnea conditions (Schumacher, 2012). Evidence supports that when comparing adults with diagnosed sleep apnea prescribed long-term opioids versus those not taking opioids, those taking opioid medications experienced increased hypoxia (Filiatrault et al., 2016). Moreover, among adults prescribed opioids for opioid use disorder, metabolic syndrome was found to be correlated with overweight BMI (Mattoo et al., 2011), suggesting that adults taking prescription opioids have risk for multi-dimensional health problems associated with overweight status. Thus, the relationship between co-occurring overweight status and chronic pain is important to explore among adults with chronic pain taking prescribed opioid medications for either opioid use disorder or management of chronic pain.

Mechanisms of Association between Weight Status and Chronic Pain

The mechanisms by which overweight status are thought to contribute to chronic pain are multi-factorial and therefore simultaneous treatment of the two conditions poses a challenge to clinicians. It will be pertinent to provide an overview of hypothesized pathways underlying the relationship between both chronic health conditions. An author-created model summarizing many proposed mechanisms can be visualized below in Figure 2.1.

Non-modifiable factors are thought to contribute to the co-occurrence of chronic pain and overweight status. One such factor is genetics, where data show that twin pairs are more likely to have chronic pain if obese than twin pairs who are normal-weight (Wright et al., 2010), and offspring are more likely to suffer chronic pain and overweight status if one or both parents have one or both conditions (Lier et al., 2016). Another contributing factor is that social and cultural norms in countries like the US emphasize food as an important part of social activities which may encourage over-consumption and the easy accessibility of ready-made, tasty, unhealthy foods facilitates over-indulgence, weight gain, and potential pain complaints (Narouze & Souzdalnitski, 2015). Low socioeconomic status has been also been linked to the relationship, emerging as a significant non-modifiable factor common across populations worldwide (Kolodny et al., 2015). Female gender has been identified as a non-modifable factor in the relationship, which is logical as women have higher prevalence of overweight status than men (Hales et al., 2017) and are more likely to report chronic pain (Fillingim, 2017). Finally, older age has emerged as strong, non-modifiable factors involved in the relationship between co-occurring chronic pain and overweight status (Stone & Broderick, 2012), which is thought to be due to the slowing of the metabolism and stiffening of joints associated with the aging process.

Other factors that may contribute to the co-occurrence of chronic pain and overweight status have the potential to be modifiable. One identified modifiable factor originates from the hypothesis that learned behaviors from the social environment, such as sedentary lifestyle and overconsumption of foods, increase risk of obesity and thus chronic pain (Bonakdar, 2013). Another contributing factor discussed above involves the increased load on joints from excessive weight which can cause painful damage (Zdziarski et al., 2015). This mechanism only partially explains the relationship, however, as overweight status has been linked to increased risk of pain in non-weight-bearing joints such as the hands (Bonakdar, 2013; Narouze & Souzdalnitski, 2015). Other modifiable health factors such as depressed mood (deWit et al., 2010), poor sleep (Mork et al., 2014), and poor self-efficacy (Janke & Kozak, 2012) have been discussed above.

A prominently cited cause of obesity-related pain is the presence of inflammatory and metabolic processes (Bonakdar, 2013; Narouze & Souzdalnitski, 2015; Okifuji & Hare, 2015; Zdziarski et al., 2015). Individuals with overweight status are more at risk than those with recommended weight status for increased levels of pro-inflammatory cytokines released by fat cells and damaged tissue matrix, such as C-reactive protein (CRP), interleukins 6, 8, and 1-β, tumor necrosis factor-α and leptin. The chronic inflammatory state activates the stress response via the hypothalamic-pituitary axis which leads to dysregulation of cortisol (Zdziarski et al., 2015), increasing pain sensitivity, creating chronic fatigue syndrome, and promoting a sedentary lifestyle which reduces likelihood of proper weight management.

In summary, the relationship between chronic pain and overweight status is complex and involves a variety of factors that are both modifiable and non-modifiable. It will be pertinent to focus research efforts on modifiable health factors of depressed mood, sleep quality, and self-efficacy for symptom management among adults with chronic pain who use prescription opioid medications. These specific health factors are related to the multi-dimensional pain experience (Wilson, 2014). Identifying relationships between modifiable health factors that are related to the pain experience may be a first step in improving pain management, especially in the context of overweight status among adults using prescription opioids.

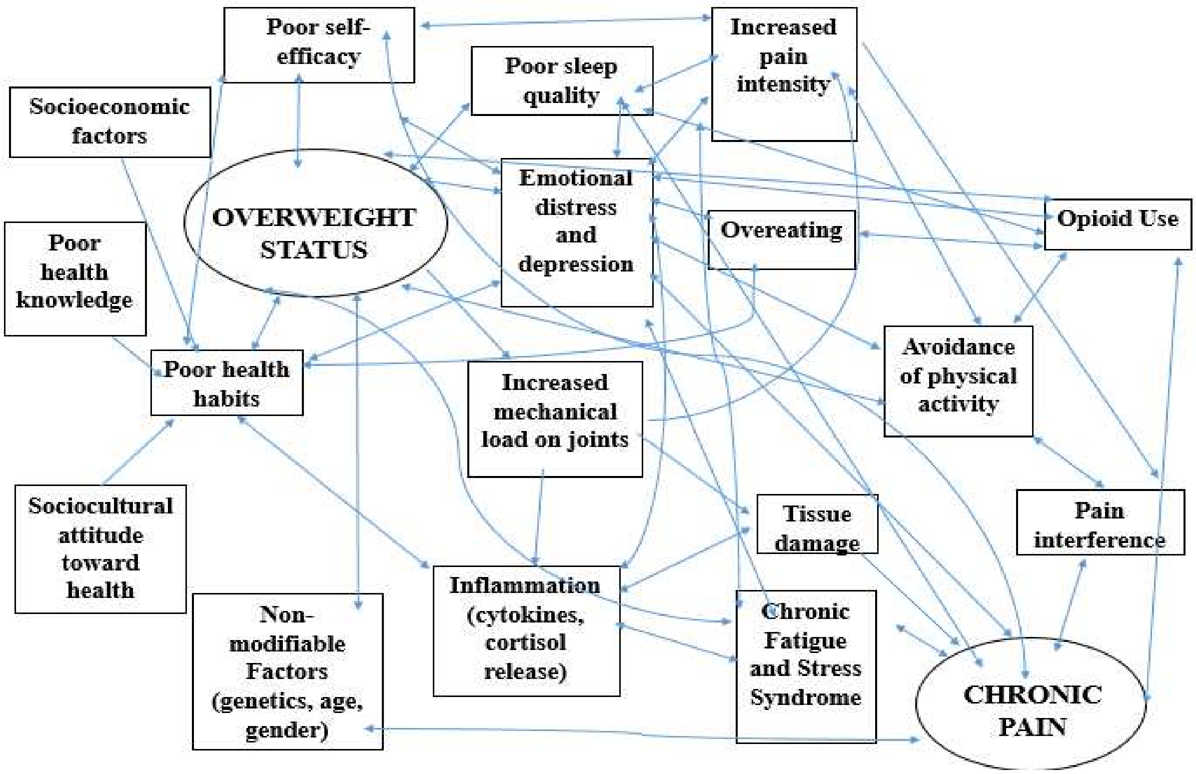

Figure 2.1. Representation of the complex, multifactorial relationship between chronic pain and overweight status.

Summary and Identification of Research Gap

The research above conducted among individuals aged 16 and older support that there is

a relationship between chronic pain and overweight status. Longitudinal studies suggest that overweight status is more important in predicting later or recurrent chronic pain as opposed to chronic pain causing weight gain and overweight status over time. The mechanisms of association between chronic pain and overweight status are complex and multifactorial (Narouze & Souzdalnitski, 2015; Okifuji & Hare, 2015). The relationship between the two conditions is influenced by many modifiable and non-modifiable factors. While there are many factors implicated in the complex relationship between chronic pain and overweight status, it was prudent to focus research efforts on sleep quality, self-efficacy for symptom management, and depressed mood as these are major components of the multi-dimensional pain experience measured by pain intensity and pain interference. Nursing science may benefit from exploration into these modifiable health factors to determine how chronic pain symptoms may be managed in an integrative fashion to offer alternative and adjunctive treatments to opioids.

Research is lacking on how modifiable health factors of depressed mood, sleep quality, and self-efficacy for management of symptoms impact weight status among adults with chronic pain who take prescription opioid medications. It is known that the use of opioid medications is linked to opioid use disorder, overdose, traffic accidents, and death (Schuchat et al., 2017) and that when prescribed to adults with overweight status, risk of fatalities related to respiratory depression increase (Schumacher, 2012). Other adverse health effects of taking opioids have been linked to overweight status. For example, a recent cross-sectional study in the United Kingdon found that adults taking medications for cardiac disease who also took opioids had significantly greater odds for having an overweight BMI, very high risk waist circumference, and high blood pressure than adults only taking meds for cardiac disease (Cassidy, Trenall, & Anderson, 2017). Furthermore, a ground-breaking randomized-controlled trial found that among more than 200 adults with chronic pain who were prescribed in a blinded fashion either an opioid medication or a non-opioid pain medication for 12 months, pain intensity and pain interference measures were better and adverse medication effects were lower in the group prescribed non-opioid medications compared to those prescribed opioids (Krebs et al., 2018). These findings provide strong evidence for the need for alternative approaches to pain self-management among adults with chronic pain who use prescription opioid medicaitons. Notwithstanding, it remains unclear whether the selected modifiable health factors impact the relationship between chronic pain and overweight status among adults who take prescribed opioid medications.

Given the dearth of findings that delineate the impact of weight status on the relationships between pain outcomes and health factors among adults using prescription opioids, it was prudent to collect observational data to better clarify the relationships. Implications could suggest that pain self-management outcomes can be achieved by targeting modifiable health-related factors such as improving self-efficacy, sleep quality, or depressive symptoms in the context of overweight status to help reduce dependence on opioid medications in this high-risk population. The current scientific literature suggests that a relationship exists among BMI and health factors of sleep quality, depression, and self-efficacy as well as BMI and pain outcomes of pain intensity and pain interference. There is a need to explore the impact of BMI on relationships between health factors and pain outcomes among adults with chronic pain using prescription opioid medications.

Theoretical Framework

Adults with chronic pain diagnoses experience many symptoms that must be self-managed in order to improve health and avoid risk for development of further pathologies. For adults with overweight status and chronic pain, symptom management and subsequent health risk reduction may be even more challenging due to patient-perceived weight stigma posed by clinicians (Setchell, Watson, Jones, & Gard, 2015b). In fact, in Australia it was demonstrated that while length of treatment time provided to adults with chronic pain by health care professionals did not differ based on weight status, average judgmental attitudes were significantly greater toward overweight clients compared to recommended weight-status clients

(Setchell et al., 2015a). Patient-perceived stigma from healthcare providers may negatively impact an individual's disease self-management behaviors and create barriers to effective symptom management in a population of adults with chronic pain and overweight status. A theoretical framework to help providers minimize stigma and provide optimal care for such patients could be beneficial.

The chosen theory guiding this dissertation is called the Individual and Family Self-Management Theory (IFSMT), and it describes individual and familial symptom management over time (Ryan & Sawin, 2009). The IFSMT was proposed by two nursing researchers. It addresses self-management behaviors and interventions for clients and family units specific to both health promotion and chronic illness. The theorists define self-management as: "a process by which individuals and families use knowledge and beliefs, self-regulation skills and abilities, and social facilitation to achieve health-related outcomes" (University of Wisconsin Milwaukee, 2016). They further state that, "self-management takes place in the context of risk and protective factors specific to the condition, physical and social environment, and individual and family" (University of Wisconsin Milwaukee, 2016). See Figure 2.2 below for the model created by the authors to describe the process by which patients manage health and chronic conditions.

The IFSMT was well-suited to the topic of overweight status and chronic pain because it is not specific for gender, age, diagnosis, type or presence of illness, or emotional versus physical health which facilitates testing in a diverse number of populations and situations. This approach is how the authors suggest that it should be tested for use in specific situations (Ryan & Sawin, 2009), although the authors do not provide explicit hypotheses about what findings would support that the model is valid. A strength of the theory is that it is built upon many other well-researched theories in the discipline of self-management and bridges gaps from prior models. A short-coming is that it is still a relatively new framework and has not yet been tested among the population of adults with co-occurring chronic pain and overweight status who take opioid medications. In fact, though the study has been cited over 300 times as evidenced by a google scholar search, there has yet to be a large enough compilation of studies testing the reliability and validity of this framework to create a meta-analysis and determine appropriate sample sizes for adequate statistical power. Therefore, the use of this theory in the present work will have to take validity testing into consideration and test some of the variables proposed in this framework for appropriateness when empowering patients to self-manage weight and related pain symptoms.

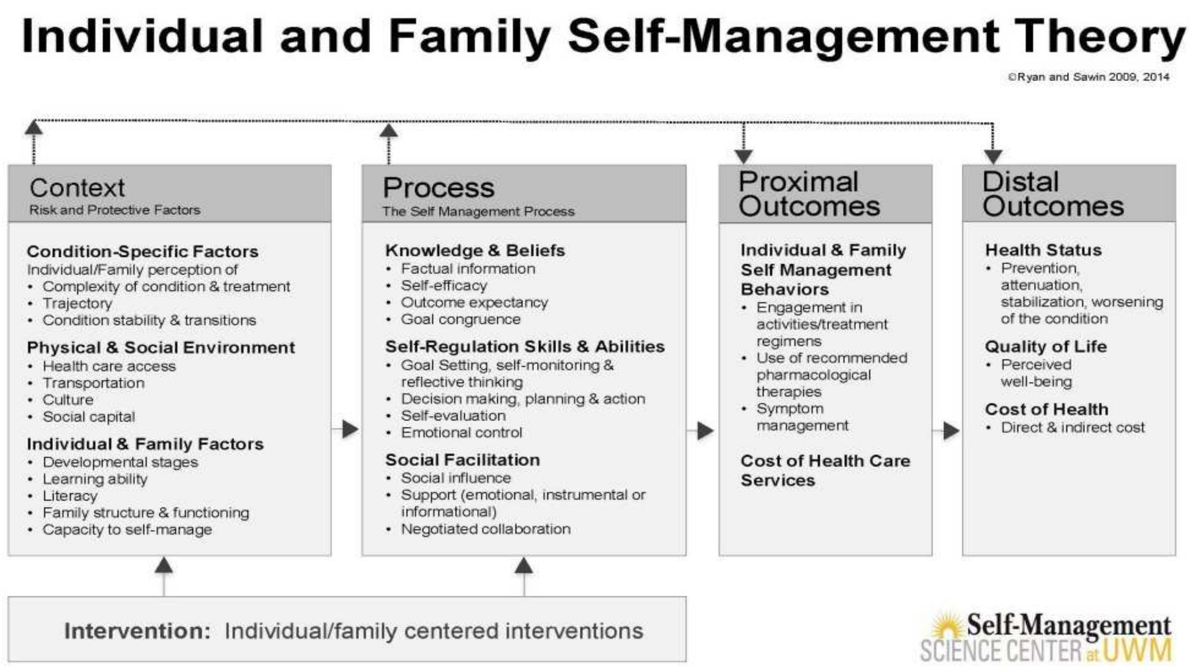

Figure 2.2. IFSMT framework outlining holistic process of disease and health self-management. Reprinted with author permission.

The IFSMT has served as the framework for several studies funded by a National Institute of Nursing Research grant to test its usefullness in the practice setting. For example, one study tested knowledge agreement among parents and adolescents regarding management of type I diabetes (Polfuss, Babler, Bush, & Sawin, 2015). In addition to studies conducted by the original authors, the theory has been used to inform research such as sleep management strategies for post-partum women (Doering, 2013). The latter is a fitting example of the application of the theory to a health promotion strategy that involves the whole family unit such as the mother, father, newborn, other siblings, and so forth. Recently, the IFSMT was used as a framework to demonstrate that among adults with overweight status taking anti-hypertensive medications, adherence to medication therapy was predicted by a healthier self-reported diet, higher levels of self-efficacy, and sleeping greater than 7 hours each night (Khalesi, Irwin, & Sun, 2017). Among adults with chronic pain, the theoretical framework was used to identify common themes for effectiveness of an online pain management program to support improved pain outcomes; themes included positive support and improved accountability (Wilson & Shaw, 2017). Thus, the framework has been demonstrated as useful at identifying factors to improve health outcomes among adults with chronic pain and overweight status.

The IFSMT can help guide health care providers' conceptualizations about the context of adults who are managing the condition of chronic pain and simultaneously attempting to reduce risk for further disease associated with overweight status. There are several assumptions that the IFSMT makes with regards to self-management of chronic conditions and health risk reduction. The first assumption is that people engage in or neglect self-management behaviors for personal reasons that may or may not be related to optimizing health levels and may not seek healthcare support in the decision (Ryan & Sawin, 2009). An example would be an adult with overweight status and chronic pain whose primary care provider advises adherence to a healthy diet to lose weight. Despite the provider recommendation, the individual decides that buying healthier food options is too costly and that cooking is too time-consuming, so the behavior is avoided. Thus, although there are health benefits to the patient's self-management of weight status through dietary changes, individually-perceived adverse consequences can outweigh the health benefits for the client, who may not feel comfortable sharing these concerns with the health care provider.

Another assumption is that decisions to engage in behaviors are multifactorial and include cultural, social, spiritual, and familial preferences and rules. Complex patient motivations for enacting health behaviors implicates the need for the provider to have a systems approach when creating health promotion or disease management interventions for clients and ensuring that interventions are collaboratively decided upon by the patient and provider. A similar assumption is that individual and family perceptions of availability and access to resources influence engagement in health behaviors. Clinicians should conduct an individualized assessment of clients' socioeconomic resources and perspectives when considering how best to support self-management behaviors among adults who are overweight with chronic pain.

The next set of assumptions relate to how best to facilitate positive proximal (short-term) and distal (long-term) outcomes of self-management strategies. One idea is that specifically-tailored individual and family-centered self-management interventions are most effective for short and long-term positive outcomes (Ryan & Sawin, 2009). In other words, using a standardized approach to encourage a population to engage in health promotion or chronic disease management behaviors may not be very effective. Each patient case will require unique considerations and interventions. A related assumption is that the accountability for and control over behaviors lies with the individual. This is a concept that health care providers need to highlight with patients; it is not the provider's role to ensure that the client engages in healthy, self-management behaviors, but it is the responsibility of the client. The health care provider should be non-judgmental when motivating the client to engage in self-management behaviors through enhanced self-efficacy. Exhibiting stigma can be detrimental as pain outcomes among adults with chronic pain and overweight status have been shown to suffer (Setchell et al., 2015a).

In addition to personal accountability, the IFSMT posits that social support is crucial in guiding individual and familial self-management behaviors. An individual who has strong support from a close family member or friend to engage in disease prevention and illness management is more likely to do so on the long-term. For example, couples who regularly opt to cook healthy meals at home together are more likely to be successful at adhering to a well-balanced diet than if one partner is insistent on eating out at fast-food restaurants daily. Lastly, the authors of the IFSMT assume that self-management is dynamic and requires repeated engagement in behaviors over time as well as patient self-reflection on progress and outcomes (Ryan & Sawin, 2009). This is important for patients to understand. For example, if a group of adults with overweight and chronic pain was engaged to become physically active for six months and all participants lost weight and reported improved pain intensity and pain interference levels, the behaviors would need to continue long-term to preserve the outcomes. If the population instead reverted to prior inactivity levels, the individuals could gain the weight back, the pain levels could again increase (Tanamas et al., 2013), and the population would again be at risk for developing preventable a chronic illness associated with overweight status. The participants would have to commit to continuing pain and weight self-management efforts after the termination of the intervention to achieve proximal and distal benefits.

Figure 2.3 below is a conceptualization of the process of the IFSMT and its potential application to research into aspects of health factors, weight status and pain outcomes among adults with chronic pain. As the figure exhibits, individual self-management of chronic pain, related symptoms, weight status, and pain outcomes can be better articulated using this framework. According to the theory, higher levels of patient and family self-management of behaviors should lead to an improvement in proximal health outcomes, and eventually in distal, or long-term health outcomes. The idea that individual health outcomes are impacted by the health of family members has been demonstrated in the literature specific to chronic pain. A large population study including more than 3,000 children and their parents found that especially for girls, the presence of parental reports of chronic pain negatively impacted self-esteem of the children (Kaasboll et al., 2015). For the research question of this dissertation, the proximal outcome of self-reported pain intensity and pain interference levels will be the focus.

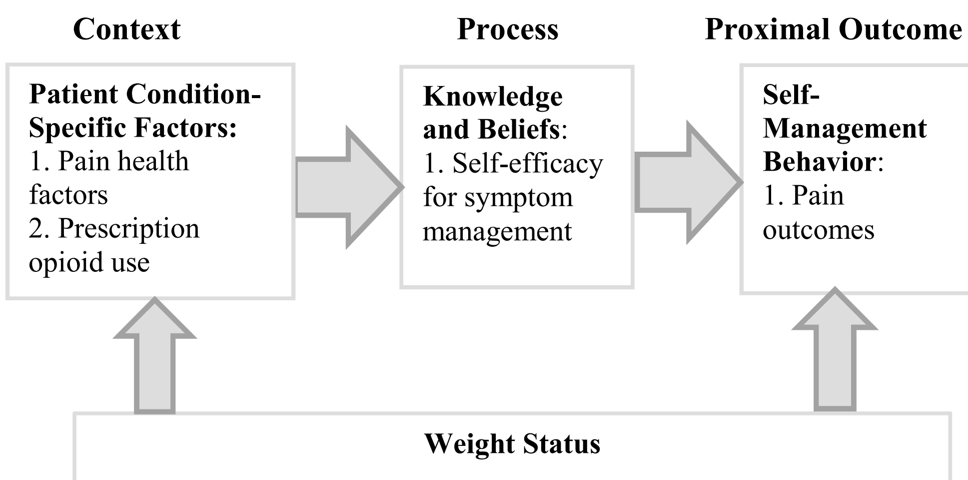

Figure 2.3. Proposal of a process to apply IFSMT to adults with chronic pain

The IFSMT facilitates translation of knowledge into practice through its pragmatic research approach, meaning that rather than testing the theory only on the very healthy or the very sick, the theory can be applied to any member of a population. The IFSMT focuses on tailoring self-management strategies to each individual and family unit. The theory is well-accepted in the nursing community as many of the professionals who have incorporated this theory into their work have been nursing professionals (Doering, 2013; Wilson & Shaw, 2017). The IFSMT was thus adopted to guide the current nursing research into the question of the role of BMI on relationships between health factors of self-efficacy, depression, and sleep quality and pain outcomes among adults who use prescription opioids.

Chapter Two Summary

The risk for reporting a chronic pain diagnosis is higher among adults with overweight status compared to adults with recommended weight status (Bigand et al., 2018). Self-reported pain levels have been found to increase in a dose-dependent relationship with BMI (Dario et al., 2015; Stone & Broderick, 2012). Weight loss has been shown to improve pain and related symptom burden among adults in this population (Messier et al., 2015), though lifestyle interventions of improving diet and exercise are less impactful for adults with high pain ratings (Masheb et al., 2015). Many factors contribute to the relationship between pain and overweight status. Some factors are non-modifiable, such as female gender (Jakobsson, 2010), older age (Allen et al.,2016), genetics (Lier et al., 2016), and high BMI at a younger age (Heuch et al., 2013). Other factors are potentially modifiable and include lifestyle factors of diet and exercise (Janke & Kozak, 2012; Lier et al., 2016; Vandenkerkhof et al., 2011), self-efficacy for managing symptoms (Pells et al., 2008), depressive symptoms (Ray et al., 2010; Tietjen et al., 2007), and sleep quality (Mork et al., 2013; Mundal et al., 2014). Although many factors are implicated in the complex relationship between chronic pain and overweight status, this study focused on sleep quality, self-efficacy for symptom management, and depressed mood as these are important concepts present in pain intensity and pain interference measures. Using the Individual and Family Self-Management Theory as a framework (Ryan & Sawin, 2009), an observational study was conducted to determine the effect of weight status on relationships between patient-specific health factors of sleep quality, depression, the process of self-efficacy for symptom management, and pain outcomes of pain intensity, and pain interference

CHAPTER THREE

METHODS

The purpose of this dissertation was to determine how overweight status is involved in the relationship between pain outcomes and health factors among adults with a chronic pain diagnosis who take prescription opioid medications using the theoretical framework of the IFSMT. Understanding which modifiable health factors are related to pain outcomes in the context of weight status among adults with chronic pain will allow nurses and other clinicians to address targeted symptom management for this population using integrative approaches adjunctive to prescription opioid use. This chapter details the procedures for data collection and the analytical plan for the study and provides rationale for the methodology.

Study Design

To test the impact of BMI on relationships between specific heath factors and pain outcomes among adults with chronic pain, a secondary analysis of data collected from a descriptive survey study was conducted. A secondary analysis of a descriptive survey study is a retrospective, observational study approach (Polit & Beck, 2016). A retrospective, observational study is favored for a dissertation project due to the cost-savings in labor, time and money and because the aims of this study are descriptive, such a study design is appropriate (Portney & Watkins, 2013). Descriptive studies are indicated to understand relationships between exposure variables and an outcome, though causality cannot be determined (Katz, 2011).

Sample

The current study analyzed data from a survey study completed between September 2016 and June 2017 whose primary purpose was to examine relationships between a variety of health measures and self-reported cannabis use among adults taking prescription opioid medications.

The inclusion criteria for the original dataset was: adult aged greater than 18 years old, taking a prescribed opioid medication for either chronic pain or opioid use disorder, and ability to provide verbal informed consent. Exclusion criteria included: inability to read or write English as this precluded survey completion and impaired mental capacity as this deterred provision of true informed consent. The sample size for the primary study was 300 adults. Of these criteria, participant data were considered eligible for inclusion in the present secondary analysis if a chronic pain diagnosis was reported by the respondent. Participant data were excluded from this study if height and weight data were missing, precluding ability to calculate BMI.

Setting

Washington State University (WSU) Institutional Review Board (IRB) approval was received (#15664-004) for the original study. In compliance with the ethical requirements of the IRB, participants were thoroughly informed of the nature of the original study, including potential benefits or health risks derived from agreeing to be involved in the following ways: a researcher explained the study on-site in a non-threatening manner, and a printed flyer was provided with full research details. If the participant was willing to be involved and met the inclusion criteria when evaluated through a brief, IRB-approved screening form, then verbal informed consent was obtained. Participants were recruited from three pain management clinics and two methadone treatment clinics in metropolitan cities in Eastern Washington via flyers placed at recruitment sites and researcher in-person recruitment. Permission to conduct the study at each facility was obtained from clinic administrators prior to initiation of recruitment. Potential participants were approached in the waiting area of clinics as they arrived for a scheduled appointment. If eligibility criteria were met and the participant gave verbal consent, pen-and-paper surveys were then administered and completed by participants in the clinic waiting area. Research personnel were prepared to expand recruitment to additional sites if less than 100 participants were recruited in the initial six months. This was unnecessary, however, as all surveys were successfully collected in the anticipated timeframe, between December of 2016 and June of 2017. Each participant was awarded a $20 Walmart gift card upon study completion.

IRB approval was requested for conduction of the proposed secondary analysis study. This IRB review was deemed exempt given the nature of the proposed study which does not require collection of new data (Washington State University, 2008). Exempt IRB reviews are completed in ten working days for the institution where the data was analyzed. Participants from the primary study did not need to be informed of this secondary analysis as minimal potential risk is presented with the omitted need to collect additional data.

Recruitment and Retention Strategy

Participants for the original study were recruited using a non-randomized, convenience, multi-site, consecutive sampling technique (Polit & Beck, 2016). This approach was the most practical given the time frame and economic constraints. The multi-site sampling technique increases the rigor of the recruitment approach as different settings and practitioner care delivery techniques may influence patient-reported health outcomes measured in the study (Portney & Watkins, 2013). No further recruitment was needed for the secondary analysis.

Data Management

Written survey responses are currently locked in a safe box in the Primary Investigator's (PI's) office which is also kept locked. The PI is the only person with access to keys to the safe box and office keys are held by WSU campus safety, the PI, and one other research assistant. Electronic data is currently held in a WSU password-protected server secured by firewalls. A minimal amount of information was collected from participants, and all participant data were de-identified. The only persons granted access to written or electronic participant information are research staff directly involved in the study.

Measures

A brief description of each variable selected for analysis in this secondary analysis will be provided here. See Appendix A for the full version of relevant tools and accompanying scoring guides listed below. Psychometrics are described in Table 3.1 below to discuss reliability and validity and provide evidence for use among adults with chronic pain.

Depression. Depression is defined as a range of symptoms including a negative or sad mood, lack of interest in life, lack of energy, suicidal thoughts, change in appetite, or change in sleep lasting more than two weeks (American Psychiatric Association, 2017). The Patient-Health Questionnaire eight-question short form was derived from the Diagnostic and Statistical Manual for Mental Health Disorders (DSM-IV) clinical diagnosis of depression (Choi, Mayer, Williams, & Gatchel, 2014). It contains eight questions and raw scores range from 0 – 24 where a higher score indicates greater presence of depressive symptoms. The scale is easy to score by adding answers from all questions together to formulate a raw score; interpretation is dependent on the raw score. If more than two answers are skipped on this measure, the raw score cannot be calculated; however, if two or less questions have been missed, a raw score may be calculated by inserting the mean of the answered questions in for the missing value/s (Kroenke, Spitzer, Williams, & Löwe, 2010). The PHQ-8 has been tested among populations of adults with pain diagnoses and demonstrated internal reliability of Cronbach's alpha between 0.86-0.92 (Choi et al., 2014). Though it has not been tested for reliability and validity among adults with overweight or obese status, it has been administered to adults with overweight and obesity in national studies (Zhao et al., 2009). The tool has also demonstrated appropriate construct validity as it is more than 90% as sensitive as the DSM-IV in diagnosis depression in the general population (Kroenke et al., 2009). This measure is therefore well-suited to use in this population and was administered to the sample analyzed in the current study.

Self-efficacy for symptom management. Self-efficacy is defined as the confidence that a person has in implementing behaviors targeted at managing personal health (Ryan & Sawin, 2009). With respect to symptom management, adults have varying levels of confidence in ability to self-manage symptoms relating to a chronic condition. For adults with chronic pain, such symptoms may refer to fatigue, poor sleep, pain interference, or pain intensity. The scale elected for measuring this construct was the PROMIS self-efficacy subscale for symptom management which has shown high internal consistency ($r>0.70$) and has high convergent validity with the well-validated Self-Efficacy for Managing Chronic Conditions scale at $r=0.76$ when administered to adults with chronic pain (Gruber-Baldini, Velozo, Romero, & Shulman, 2017). It was chosen to be measured in this study using a Patient-Reported Outcomes Measurement Information System (PROMIS) pain interference sub-scale. PROMIS tools were developed from a national effort to create standardized, reliable, valid measures of patient-reported outcomes available to all researchers. The use of standardized tools in research allows for homogenous outcomes to reduce conflicting results that may occur from the use of tools that use varying construct definitions. This subscale therefore is adequate to measure self-efficacy in the population of adults with chronic pain.

The PROMIS self-efficacy for symptom management contains a total of 4 questions. The raw score of this subscale ranges between 4 – 20 where a higher raw score indicates higher levels of self-efficacy. Because this scale only contains four questions, a score cannot be approximated if all answers are not completed by the participant (NIH, 2015c). The raw score of this subscale is converted to a t-score. A t-score of 60 or greater indicates one standard-deviation higher self-efficacy than the average population and a t-score of 40 or less reflects one standard-deviation less self-efficacy than that reported by the general healthy population. See Appendix A below for a chart detailing the conversion of the raw score to the t-score.

Sleep quality. Sleep quality refers to how well a person perceives the state of his or her overall sleep to be over time. This construct was measured in the current study through the Pittsburg Sleep Quality Index (PSQI) global score (Buyesse et al., 1988). This was chosen because it is a well-known scale that is widely used in the sleep literature to link patient-reported outcomes to sleep quality (University of Pittsburg, n.d.). A meta-analysis of the reliability and validity of this scale found that the PSQI demonstrated high convergent validity as it was 100% sensitive in diagnosing insomnia according to the DSM-IV among adults with low back pain with a cut-off global score of 6 and highly correlated with other sleep measures such as the well-validated sleep measure, the Insomnia Severity Index ($r=0.80$); it also demonstrated good divergent validity as it was weakly correlated with non-related sleep measures such as social support ($r=-0.14$) (Mollayeva et al., 2016). In addition, the PSQI has shown acceptable test-retest reliability of 0.83 (Buyesse et al., 1988) among adults with and without diagnosed sleep disorders, thus increasing confidence in the appropriateness of this measure for the current study.

The PSQI presents relatively low participant time burden to complete. There are 19 items in total on this measure that are grouped into seven component scores which include the sub-categories of sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medications, and daytime dysfunction. All component scores are summed to make a global score. Global scores range from 0-21 (Buyesse et al., 1988), where a score of five or greater indicates clinically significant poor sleep, though a higher cutoff score of seven or greater has been recommended for detecting poor sleep quality among adults with chronic low back pain (Alsaadi et al., 2013). All questions from the scale need to be answered in order to compute a global score, except one item which asks participants to list "another" reason for poor sleep. If this question is skipped, the researcher may assign a "0" value (Pittsburg Sleep Quality Index, 2005). If a significant number of global scores are missing (≥20%), the component score with the highest correlation to the global score can be used to estimate total score (Buyesse et al., 1988).

Pain interference. Pain interference refers to the degree to which pain limits emotional and physical functioning (NIH, 2015b). Pain interference was measured with the PROMIS pain interference subscale, a low time-burden, eight-question scale with high test-retest reliability (Cronbach's alpha=0.84) and high correlation between electronic versus pen-and-paper methods of administration over time (r=0.83-0.91) when tested among adults with chronic pain (Broderick et al., 2013). Furthermore, the scale shows high convergent validity among adults with chronic pain, correlated at r=0.7 with a pain interference subscale well-validated and reliable measure of pain, the Brief Pain Inventory (BPI), and good divergent validity as the tool poorly correlates with the pain intensity subscale of the BPI at r=0.29 (Cook et al., 2015). The PROMIS pain interference subscale is thus appropriate to be used for this study.

The raw score of the PROMIS pain interference subscale ranges between 8 – 40, where a higher number indicates higher levels of pain interference. The raw score can be estimated if at least 50% or 4 questions are answered. This is done by adding up the total of the answered items, multiplying by the number of questions on the short form, dividing by the number of questions answered, and inserting this value rounded up to the nearest whole number for the missing value/s (NIH, 2015b). Once raw scores have been tabulated, they are then converted to t-scores based on whether the raw score falls within one standard deviation above or below the mean of the general population (t-score of 50). One standard deviation is defined in this case as a t-score of ten more or less than 50. In other words, a t-score of 60 or greater indicates higher pain interference than average and a t-score of 40 or less reflects less pain interference than average. See the Appendix A below for a chart detailing the conversion of the raw score to the t-score.

Pain intensity. Pain intensity is another patient self-reported concept that measures the degree of pain experienced by the person (NIH, 2015a). In the present study, pain intensity was measured by the pain intensity PROMIS subscale 3-question short form. This subscale showed high 1-week test-retest reliability when administered to adults with chronic pain conditions at a Cronbach's alpha of 0.83 as well as reliability over time among different methods of administration where r=0.83 - 0.91 (Broderick et al., 2013). The sub-scale demonstrated high, statistically significant convergent validity with the Neck Disability Index severity sub-score among adults with chronic neck pain conditions (Boody et al., 2018). Thus, this measure was appropriate to use for the study at hand.

Pain intensity is scored in the same way as pain interference, except raw scores cannot be estimated if questions were skipped. The raw score of this subscale ranges between 3– 15 (NIH, 2015a) and higher raw score indicates higher levels of pain intensity. The raw score is converted to a t-score and interpreted based on whether the t-score is within one standard deviation above or below the mean of the general population (t-score of 50). A standard deviation is defined in the same manner as pain interference, where a t-score of 60 or greater indicates higher pain interference than average and a t-score of 40 or less reflects less pain interference than average. See Appendix A below for a chart detailing the conversion of the raw score to the t-score for this PROMIS subscale.

BMI. Weight status was represented by a measure of BMI, defined as weight (kg)/height $(m)^2$. The measure of BMI is highly correlated with other measures of weight status such as body fat percent or waist-hip ratio, showing high convergent validity among adults with pain complaints (Heuch et al., 2015). In many large cross-sectional studies exploring relationships between chronic pain and overweight status among adults, self-report height and weight data is collected to approximate BMI values (Stone & Broderick, 2012; Wright et al., 2010). Some evidence suggests that self-report BMI values are not as acceptably accurate as professionally-measured values (Rothman, 2008). A recent study conducted among women with chronic pain diagnoses, however, found that while a minority of obese women with osteoarthritis were most likely to under-report BMI and change categories, there was no significant difference between participants who were correctly classified in corresponding BMI categories by self-report compared to researcher-measured methods (Skeie, Mode, Henningsen, & Borch, 2015). In addition, unpublished pilot data from the study population (n = 11) found a very high correlation (r=0.99, p<0.001) between researcher-measured and participant-reported height and weight data, and thus self-report numbers for BMI were used with fair degree of confidence

The data analyzed for this secondary analysis included only self-report height and weight data. Conflicting data exists on the reliability of self-report versus researcher-measured BMI data in the adult chronic pain population. Thus, a pilot study involving the target population of adults with chronic pain in one of the major pain clinics used in the original study was conducted from August 2017 to February 2018. The aim of the small pilot study was to verify accuracy of self-report height and weight data for calculation of BMI as compared to researcher-obtained height and weight data among adults with chronic pain. Participants in the pilot (N=8) had an accurate height and weight measurement taken by a researcher at two time-points if possible. The same participants were also asked to self-report height and weight in an initial survey. In total, eleven BMI time-points were collected for comparison where two data points were from male participants and nine data points were from female participants.

To collect measurements for BMI, a standard stadiometer from Perspective Enterprises was used by a researcher for accurate height measured to the nearest centimeter. Participants were asked to remove footwear and stand with back and buttocks against the instrument, and height was recorded to the nearest centimeter. Weight was obtained using a calibrated, portable electronic scale, a Tanita BWB-800, measured to the nearest tenth of a kilogram. For weight measurement, participants were asked to removed footwear and any additional outer clothing such as jackets or gloves for improved accuracy. BMI was calculated from these measurements according to the appropriate equation: $(kg)/(m)^2$. Pearson's correlation coefficient was calculated to determine how well the researcher-measured versus participant-reported BMI values were related. The pilot data supported the use of self-report height and weight data to calculate an accurate BMI among adults with chronic pain diagnoses as the Pearson's correlation coefficient was very high (r=0.99, $p<0.001$), indicating a good fit between self-report and researcher-measured BMI. Thus, there is a good degree of confidence in using self-report data that adults were correctly classified as either obese, overweight, or recommended weight status.

Table 3.1.
Study Tools and Psychometric Properties

Construct	**Instrument**	**Psychometrics**	**Score Range**	**Cut-off Score**
Patient Demographics	Education level, age, ethnicity, occupational status, socioeconomic status, gender, marital status by self-report	Face validity established among researchers; patterned after forms used in comparable, published survey studies among	N/A	N/A

		adults with chronic pain		
Depressive Symptoms	Patient Health Questionnaire-8	Combined sensitivity and specificity of 79% when compared to a structured clinical interview in diagnosing depression among adults with chronic pain (Choi et al., 2014).	0-24	PHQ-8 ≥ 10
Self-Efficacy for Symptom Management	PROMIS Self-Efficacy for Symptom Management	Short form answers correlated highly with long-form among adults with chronic pain (r>0.85); long-form has 0.76 correlation with valid, reliable self-efficacy scale = convergent validity (Gruber-Baldini et al., 2017).	24.93-62.12	T- score ≥ 50
Sleep Quality	Pittsburg Sleep Quality Index	Cronbach's alpha 0.83 among adults with and without sleep impairments (Buysse et al., 1988).	0-23	PSQI ≥ 7
Pain Interference	PROMIS Pain Interference-SF	0.84 test-retest reliability among adults with chronic pain (Broderick et al., 2013).	40.7-77.0	T-score ≥ 60
Pain Intensity	PROMIS Pain Intensity-SF	0.83 test-retest reliability among adults with pain (Broderick et al., 2013).	30.7–71.8	T-score ≥ 60
Weight status	Body mass index	BMI is correlated with other anthropometric measures = convergent	>18.5	Recommended Weight: BMI = 18.5 – 24.9

		validity (Heuch et al., 2015).		Overweight: BMI = 25 – 29.9 Obese: BMI ≥ 30

Data Analysis

Data were analyzed using version 25 of IBM SPSS statistics software and Microsoft Office 365 Excel version 1708. As part of the data screening process, frequency statistics were run to detect missing data on each variable. If missing scores impacted a significant (greater than 20%) number of total scores for a given variable, multiple methods were planned to be used for analysis of that variable (Katz, 2011). First, cases with missing values were planned to be deleted list-wise and analysis was to be conducted without the missing cases. Then, substitution of the mean (or median, if the variable distribution does not follow a bell-shaped curve) for missing cases was to be employed and analysis re-run including these cases. Lastly, a linear regression technique was to be conducted to predict the missing value for each component score of the scale in question. Using multiple methods to approach missing data allow researchers to understand if there are meaningful differences in the overall findings. Ideally, the main findings remain the same regardless of how missing data is handled from the methods mentioned here (Katz, 2011). If there were differences among the approaches, the more conservative method for dealing with missing data was planned to be utilized for the major data analysis. This was defined as the method that produced the highest p-value.

After missing data were screened and addressed, data were screened for normality using histograms, means and standard deviations, skewness and kurtosis, and Q-Q plots to assess of distribution of all independent and outcome variables. In addition, scatterplots of all variables of interest were generated to assess for linearity and homoscedasticity of data where shapes should resemble elliptical figures (Mertler & Vannatta, 2013). A residual plot was created with the outcome variables of pain interference and pain intensity on the y-axis and the independent variables on the x-axis. Normality was assumed if data did not appear to be clustered in one area of the residual plot. Once assumptions were met, a linear regression was conducted using a blocking method. The health factors (depressive symptoms, sleep quality, and self-efficacy for symptom management) were entered in the first block, then BMI was entered in the second block, and finally in block three, demographic variables of age and gender were entered as covariates. Output from the linear regression allows the researcher to determine how much influence each independent variable exerts over the variance in the outcome variables (Katz, 2011). Such knowledge highlights which aspect of symptom management may be most impactful for clinicians to address among adults with chronic pain, especially in the context of overweight status and prescription opioid use. If assumptions were unable to be met to run a linear regression, a non-parametric multinomial logistic regression was planned to be conducted instead. While this would have resulted in a loss of power by collapsing continuous data in categories (Mertler & Vannatta, 2013), major findings should have been the same regardless of the approach with a sample size greater than 50 cases (Pohar, Blas, & Turk, 2004).

In the following section, each specific aim will be described along with the corresponding detailed analytic plan.

Specific aim #1: to characterize a sample of adults reporting chronic pain. Using SPSS version 25, frequency and descriptive statistics were performed on demographic data to address the first study aim. Demographic data included gender, age, education, yearly income, occupational status, ethnicity, presence of a mental health disorder, and participant treatment center type (opioid use disorder center or chronic pain clinic). Missing data for these demographic variables were reported as well as percentage of adults who fell into each category. A series of t-tests and ANOVAs were conducted with BMI as the continuous variable to determine group differences based on weight status. Several chi-square tests and a logistic regression were conducted to explore demographic differences between adults attending the two types of treatment centers.

Descriptive statistics were run on each independent variable (pain intensity, pain interference, sleep quality, self-efficacy for symptom management, and depression) as well as the outcome variable (weight status) as part of the normality screening process to identify outlier data and to assess central tendencies (Mertler & Vanatta, 2013). Means and standard deviations were reported for all variables.

Specific aim #2: to determine the relationship between BMI, pain intensity, and pain interference among adults with chronic pain. After screening data for normality and critically apprising missing data, bivariate relationships among all independent and outcome variables were run. This determined which variables were significantly related and the direction of relationship. Data were considered statistically significant at a p-value≤ 0.05.

Relationships among chronic pain and obesity were tested in two ways. The first was to conduct either a Pearson's correlation coefficient or Spearman's rho (rho) if normality could not be assumed to test the strength of correlations between pain intensity and BMI and pain interference and BMI. A value of $r \geq 0.20$ with a p-value≤ 0.05 was considered as correlated with BMI at least at moderate strength (Holcomb, 2016). The second method was through a series of chi-square tests to calculate risk and odds ratios. In order to complete the chi-square tests, each independent pain variable was converted into a categorical state where 1=positive for a high pain measure and 0=low pain measure. BMI was re-coded into a categorical state where 0=recommended weight status (BMI 18.5 – 24.9), 1=overweight status (BMI 25-29.9) and 2=obese status (BMI ≥30).

Two markers of the pain experience within a population suffering chronic pain conditions are pain intensity and pain interference (Younger et al., 2009). Both pain outcomes tend to be highly correlated, meaning that they cannot be entered simultaneously as independent variables in a regression model to avoid multicollinearity (Mertler & Vannatta, 2013). Thus, in the proposed secondary analysis, the plan was to run two separate analyses to investigate the impact of health factors on each pain outcome in the context of overweight status. To understand relationships between pain outcomes and weight status, a series of risk and odds ratios were calculated from chi-square tables where pain intensity, BMI, and pain interference are separated into nominal data. See Table 3.2 for an example risk and odds ratios measuring high pain intensity among adults with obesity versus recommended weight status and overweight versus recommended weight status. Adults were categorized into either obese (BMI ≥ 30), overweight (25 ≤ BMI <30), or recommended weight status (BMI < 25). Pain intensity was dichotomized by a t-score of ≥60 on the PROMIS pain intensity sub-scale as having high pain intensity for chronic conditions (1), or <60 t-score as not having high pain intensity (0) as these values are one standard deviation above the mean for the general population and are recommended values for those with pain. Pain interference was dichotomized with the same metrics as pain intensity.

Table 3.2

Chi-Square Calculation to Test Risk for Pain Intensity Based on Weight Status

All adults in sample	High Pain Intensity (H)	Not-high Pain Intensity (Np)	Total	Risk	Risk Ratio	Odds	Odds Ratio
Obese (O)	OH	Onp	OH+Onp	OH/(OH +Onp)	O Risk/R risk	OH/Onp	O odds/R odds
Overweight (Ov)	OvH	OvNp	OvH+OvNp	OvH/(OvH +OvNp)	Ov Risk/R risk	OvH/OvNp	Ov odds/R odds
Recommended weight (R)	RH	RNp	RH+RNp	RH/(RH+RNp)		RH/RNp	

After calculating values for risk and odds ratios for both pain intensity and pain interference for both adults with overweight and obesity, chi-square values were computed. If $p \leq 0.05$, values were considered statistically significant. To further test the degree of confidence in computed values, a free online risk ratio calculator was used to determine the 95% confidence intervals for the computed risk ratios (MedCalc, 2018). The pain outcome variable that demonstrated a stronger relationship with BMI was used in the multivariable analysis.

Specific aim #3: test the relationships between specific factors and BMI. To address the last aim, a variety of approaches were taken. First, each predictor variable had a Pearson correlation coefficient, *r,* (or a Spearman's rho, *rho*, if normality cannot be demonstrated) calculated to test the correlation with BMI. An $r \geq 0.20$ with $p \leq 0.05$ was considered of moderate significant relationship.

Next, each independent variable was tested using stratified chi-square analyses to measure degree of relationship with the outcome variable. See Table 3.3 below for a detailed outline of the process. In the table, independent variables of sleep quality and pain intensity are shown as an example of the stratification analysis comparing adults with overweight status to adults with recommended weight status and again adults with obesity to adults with recommended weight status.

To explain the process using the case of depressed mood and pain intensity, two chi-square analyses were run to explore the impact of depression on the relationship between pain intensity and overweight status: one restricted to adults with high depression comparing pain intensity levels among weight categories, and one restricted to adults with low depression. According to the literature, a cut-off score of ten on the PHQ-8 has high sensitivity for diagnosis of depression among adults with chronic illnesses (Pettersson, Bengtsson, Gustavsson, & Ekselius, 2015). Thus, among adults with a PHQ-8≥10 (indicating presence of at least moderate depression), risk and odds ratio were calculated for high pain intensity for adults with overweight compared to recommended weight status and obesity compared to recommended weight status. The calculations for each chi-square model included the chi-square p-value to demonstrate significance of risk and odds ratios and the 95% confidence intervals for all risk and odds ratios. The purpose for conducting a series of stratified chi-squared analyses was to determine if each independent variable acted as an effect modifier by changing the relationship between chronic pain and overweight status in a meaningful way. Alternatively, the independent variable could have acted as a confounder, which blurs the effect of the exposure variable on the outcome variable (Katz, 2011). In the same manner, chi-square models were conducted using the independent variables of depression, self-efficacy, and sleep quality for pain control as stratifying variables.

The steps described above were taken to test the impact of self-efficacy for symptom management on the relationship between pain and weight status in the sample. A cut-off t-score of 50 was used to determine presence of self-efficacy where<50 indicates a low level of self-efficacy for managing pain symptoms (NIH, 2015c). Risk and odds ratios were calculated for adults with low levels of self-efficacy comparing those with obesity to recommended weight and overweight to recommended weight who have high and low levels of pain intensity. The procedure was replicated for the pain measure of pain interference, and again for those in the sample with high levels of self-efficacy. Chi-square p-values and 95% confidence intervals were computed for all risk and odds ratios.

The same technique was executed for adults who report high and low levels of sleep quality within the sample based on global PSQI scores. As noted previously, a cut-off global PSQI score of six is appropriate to use for adults with chronic pain conditions. Thus, among adults with a PSQI >6 (indicating presence of poor sleep quality), risk and odds ratio were calculated for high pain intensity and risk and odds ratio for high pain interference for adults with overweight compared to recommended weight status and obesity compared to recommended weight status. Chi-square values and 95% confidence intervals were computed for each respective relative risk value. These procedures were repeated to determine whether adults with PSQI≤6 had different risk ratio values than adults with poor sleep quality.

Table 3.3

Sample Chi-Square Stratification by Independent Variable Sleep Quality

Adults with high-quality sleep	High Pain Intensity (H)	Not-high Pain Intensity (Np)	Total	Risk	Risk Ratio	Odds	Odds Ratio
Obese (O)	OH	Onp	OH+Onp	OH/(OH +Onp)	O Risk/R risk	OH/Onp	O odds/R odds
Overweight (Ov)	OvH	OvNp	OvH+OvNp	OvH/(OvH +OvNp)	Ov Risk/R risk	OvH/OvNp	Ov odds/R odds
Recommended weight status I: reference category	RH	RNp	RH+RNp	RH/(RH+RNp)		RH/RNp	

Adults with low-quality sleep	High Pain Intensity (H)	Not-high Pain Intensity (Np)	Total	Risk	Risk Ratio	Odds	Odds Ratio
Obese (O)	OH	Onp	OH+Onp	OH/(OH +Onp)	O Risk/R risk	OH/Onp	O odds/R odds
Overweight (Ov)	OvH	OvNp	OvH+OvNp	OvH/(OvH +OvNp)	Ov Risk/R risk	OvH/OvNp	Ov odds/R odds
Recommended weight status I: reference category	RH	RNp	RH+RNp	RH/(RH+RNp)		RH/RNp	

All predictor variables were tested for multicollinearity by running a linear regression and selecting "collinearity diagnostics" in SPSS version 25. All independent variables that did not violate multicollinearity assumptions of being too highly correlated with another independent variable as defined as a VIF of less than ten (Mertler & Vannatta, 2013) were entered in a multiple linear regression model if assumptions were met as described above. Alternatively, if assumptions for a parametric test were not met, the less powerful multinomial regression was planned. A multinomial regression was used to uncover significant findings about an ordered categorical outcome in a published study among adults with chronic pain and overweight status (Allen et al.,2016). Thus, it would have been appropriate to use a multinomial regression to explore pain intensity and pain interference as categorical, ordered outcomes among adults with chronic pain for this study if indicated. Theoretically, if the variables are non-normally distributed, the multinomial logistic regression is the correct statistical method to use (Mertler & Vannatta, 2013). Despite suffering a loss of power with the logistic versus linear regression, with a sample size of greater than 50, it has been demonstrated that the multinomial logistic regression performs just as well as the more statistically powerful analytic method of discriminant analysis (Pohar et al., 2004). As the current study had greater than 50 participant cases for analysis, the multinomial logistic regression would have been a suitable approach for estimating risk via odds ratios for pain outcomes among adults with chronic pain based on presence or absence of specific health factors in the context of overweight status if data had violated assumptions of the linear regression.

Conduction of a regression model explored which variables significantly predicted the outcomes of pain intensity and pain interference and how BMI changed the relationship between health factors and pain outcomes. The independent variable of BMI was planned to either be left as continuous for a linear regression or converted into categories for the logistic regression (0 for recommended weight status, 1 for overweight, and 2 for obese). Dependent pain variables were entered in the regression model as either continuous or dichotomous categorical variables depending on whether the linear versus the logistic regression model could be run. A blocking method was employed to conduct the regression models. The health factors were entered into the first block, then BMI was entered in the second block. Age and gender were added into the third block to control for these effects as these factors have been shown to be related to chronic pain conditions in adults. Two models were run; one with pain interference as the outcome and one with pain intensity as the outcome. The model that achieved statistical significance ($p < 0.05$) with the least amount of predictor variables was considered the best fit (Portney & Watkins, 2013) for explaining the relationship between pain and health factors in the context of BMI.

Power Analysis

Power analysis is an important consideration when designing a primary study. This ensures that a desired treatment effect is observed within the sample based on the number of participants in the study (Portney & Watkins, 2013). Due to the observational nature of this secondary analysis, a power analysis is not applicable as there is no hypothesized effect size. Thus, the study at hand did not consider a power analysis and assumed that any number of cases over 100 would offer sufficient power to avoid a Type II error (Katz, 2011). Measures to ensure validity of research findings were employed and will be described next.

Validation

Methods of internal and external validity were conducted as part of this secondary analysis. This is an important way to protect against making a type I error (finding a significant relationship at random, where none exists) and to see if findings are truly generalizable and representative of the population under study (Portney & Watkins, 2013). Internal validation was completed by randomly splitting the entire data into two files and running the regression model on both samples. Findings among the random samples should have been comparable to major findings from the model run on the entire sample to demonstrate internal validity.

External validation was performed as well. While data collected for the primary study included information from adults taking prescribed opioid medications, two separate populations were recruited to complete surveys. The two populations were adults receiving active treatment for a chronic pain condition and adults receiving active treatment for opioid use disorder. While the prevalence of chronic pain among populations of adults in treatment for opioid use disorder have been cited as approximately 65% with more than half citing chronic pain as precipitating opioid use disorder (Hser et al., 2017), adults receiving active treatment for opioid use disorder are thought to differ from adults receiving active treatment for chronic pain. Thus, of the 300 adults who participated in the primary study, 150 adults were recruited from chronic pain centers and 150 adults from opioid use disorder treatment centers. To perform external validity testing, a regression model was run on the population with chronic pain and on the population with opioid use disorder. As the two populations are comparable yet distinct, major findings of the regression conducted among the entire sample should have been similar for the individual populations to demonstrate external validity.

Chapter Three Summary

The current secondary analysis was conducted to test the impact of overweight status on the relationship between and health factors and pain outcomes among adults with chronic pain. The health factors included sleep quality, depression, and self-efficacy and have been identified from a literature review as being common to the population of adults with chronic pain who have co-morbid overweight status. The health factors are also important considerations of the chosen pain outcomes: pain intensity and pain interference. The theoretical framework of the IFSMT was used to guide the inquiry. Pearson correlation coefficients (or Spearman's rho values) were calculated to demonstrate correlation between independent variables and the outcome. Chi-square tables were utilized to calculate risk and odds ratios to analyze the bivariate relationships between pain intensity and overweight status as well as pain interference and overweight status. The sample was stratified, and chi-square calculations were re-run to determine the impact of sleep quality, depression, and self-efficacy on the relationship between pain variables and BMI. The health variables were entered into a linear regression using a step-wise method controlling for age and gender as covariates with pain interference as the outcome for one model and pain intensity as the outcome for a second model. The proposed descriptive study design was adequate and appropriate to address the impact of overweight status on the relationship between pain outcomes and health factors among adults with chronic pain. The plan to assess external and internal validity of findings strengthens confidence in generalizability of results to similar clinical populations.

CHAPTER FOUR

RESULTS

The research findings are presented in detail in this chapter. The main purpose of the research project was to determine relationships between health factors of sleep quality, depression, self-efficacy for symptom management, pain interference, pain intensity, and weight status among adults with self-reported chronic pain conditions regularly taking prescribed opioid medications. Such knowledge will be important to improve health outcomes by providing an evidence base for all health care providers regarding holistic care for adult using chronic pain using prescription opioids. All identified relationships between health factors are described, including which factors are most strongly related to pain outcomes. Data analysis is presented on all levels conducted including univariate, bivariate, and multivariable approaches.

Sample Selection

Washington State University Institutional Review Board deemed the current secondary analysis to be exempt (IRB # 16921). The primary data set, described briefly in chapter three of this document, surveyed a total of 300 adults taking prescription opioid medications. The present secondary analysis included cases if the respondent was 18 years or older, reported presence of a chronic pain condition, and had data available to calculate BMI. While similar studies report exclusion of adults with an underweight BMI (Wright et al., 2010), in the present dissertation study, only six cases meeting inclusion criteria contained a BMI<18.5 kg/m^2. The decision was made by the student and committee methodologist to preserve the cases as the analysis showed that the small number was not observed to impact findings or interpretation. Underweight cases were thus categorized with recommended weight cases when separating groups by BMI category. Data screening procedures were initiated using frequency statistics. After applying all inclusion criteria and screening for missing data, the remaining sample with complete cases for all variables of interest for this study was comprised of 168 cases out of a total possible 233 cases as seen in Table 4.1.

Table 4.1 Frequencies and Standard Deviations of Variables of Interest

		Sleep quality	Depression	Self-efficacy	Pain Intensity	Pain Interference	BMI	Age
N	Valid	174	231	229	215	233	226	233
	Missing	59	2	4	18	0	7	0
Mean		11.55	10.94	44.53	58.03	66.71	30.43	48.55
Median		12	10	44.56	56.31	66.91	28.42	50
Minimum		1.0	0	24.9	30.7	40.7	14.7	19
Maximum		21	24	62.12	71.80	77.00	62.71	85
Std. Deviation		4.57	6.06	7.73	6.47	6.78	8.57	14.66

Most missing cases (59 out of 233) were noted to be related to the PSQI global score used to measure sleep quality. This scale consists of 19 questions calculated into seven different component scores which are summed for a resulting global score ranging from 0 – 21 where increasing scores indicate worsening perceived sleep quality. However, the global score cannot be calculated if even one of the 19 questions is skipped (Burkhalter et al., 2010). Other studies using the PSQI have found similar trends of high percentage of missing PSQI data when administering the scale to clinical populations. Item analyses of the scale have demonstrated highest correlations with the global score and component score one (Beck et al., 2004). Thus, to explore if an individual component score could be used in the present study to best estimate the global score and decrease number of missing cases, an item analysis was performed using correlation statistics among those who answered any of the questions on the PSQI. See Table 4.2 for calculated statistics below. Similar to prior studies (Beck et al., 2004), component one was found to be most highly correlated with the total global PSQI score. Thus, component score one was chosen to estimate the global score. The rationale was to mitigate loss of power from greater than 20% of missing data when deleting listwise all cases without a PSQI global score. This change increased the sample size to 223 cases with complete scores for all variables of interest.

Table 4.2 Cronbach's Alpha of all Component Scores and PSQI Global Score

Component + Global Score	**Cronbach's Alpha**
All components	0.75*
Component 1	0.74*
Component 2	0.51*
Component 3	0.68*
Component 4	0.46*
Component 5	0.69*
Component 6	0.73*
Component 7	0.49*

*=p<0.05

Data Screening

Further data screening and analysis began after identifying the sample. The steps taken are summarized in Table 4.3 below. Frequency and descriptive statistics revealed that for all variables of interest, the mean and median values were very close, supporting normal distribution of each variable. Next, outlier data were assessed after missing data were addressed as detailed above. Many data points were found to be outliers for all variables of interest. However, as the proposed plan was to conduct a linear regression model, a scatterplot matrix was created to assess normality with all cases included to meet assumptions to run the parametric test. All variables followed an elliptical pattern as seen in figure 4.1 below, and normality and linearity were assumed. Thus, no outlier cases were removed from analysis. Furthermore, a residual scatterplot matrix using pain interference as the dependent, continuous variable revealed a lack of clustering of residual data points as seen in figure 4.2 below. Using pain intensity as the continuous outcome variable also revealed a lack of clustering in figure 4.3, meeting assumption for homoscedasticity to allow both multiple linear regressions to be conducted.

Table 4.3 Outline of Data Screening and Analysis Procedures

Action	Process	Justification
Screen for missing data	1. Run explore in SPSS 2. Move all quantitative variables to variables box 3. Analyze output and quantify missing cases 4. Develop strategy to address variables with >20% missing cases	Mertler & Vannatta, 2013, pg. 63
Screen for outliers	1. Run explore in SPSS 2. Outcome variable (BMI) to dependent list and predictor variables to factor list 3. Check descriptives and outliers in statistics 4. In plots, check boxplots, factor levels together and stem-and-leaf 5. Analyze outliers 6. Develop strategy to address outliers	Mertler & Vannatta, 2013, pg. 63
Screen for homoscedasticity	1. Run normality plots in explore in SPSS 2. Run linear regression to create a residual plot 3. Within Plot, select ZRSID for the y-axis and ZPRED for x-axis 4. Evaluate scattering of residuals throughout plot	Mertler & Vannatta, 2013, pg. 191
Screen for normality/linearity	1. Create scatterplot matrices of all variables 2. Outcome (pain intensity or pain interference) to dependent variables box, predictors to independent box 3. Evaluate elliptical shape of output	Mertler & Vannatta, 2013, pg. 191
Run risk and odds ratios with stratification	1. Convert variables to dichotomous within Excel 2. Set up risk and odds ratios	Cummings, P. (2009).

	3. Calculate confidence intervals and p-values of all output	
Calculate Pearson's Correlation Coefficients	1. Run correlate in SPSS 2. Correlate all variables with outcome, BMI 3. Develop strategy to address weak or insignificant correlations with outcomes 4. Determine which pain variable more strongly correlated with BMI 5. Determine if predictor variables are strongly correlated and consider using only one variable to avoid multicollinearity	Mertler & Vannatta, 2013
Run linear regression	1. Re-run linear regression with blocking strategy 2. Pain variable more strongly predictive of BMI in first block, age and gender in second to control, then remaining independent variables in final block 3. Within the Statistics tab, select: estimates, model fit, R squared change, descriptives, part and partial correlations, and collinearity diagnostics	Mertler & Vannatta, 2013, pg. 191
Interpret results	1. Summarize steps and significant findings	Mertler & Vannatta, 2013, pg. 191

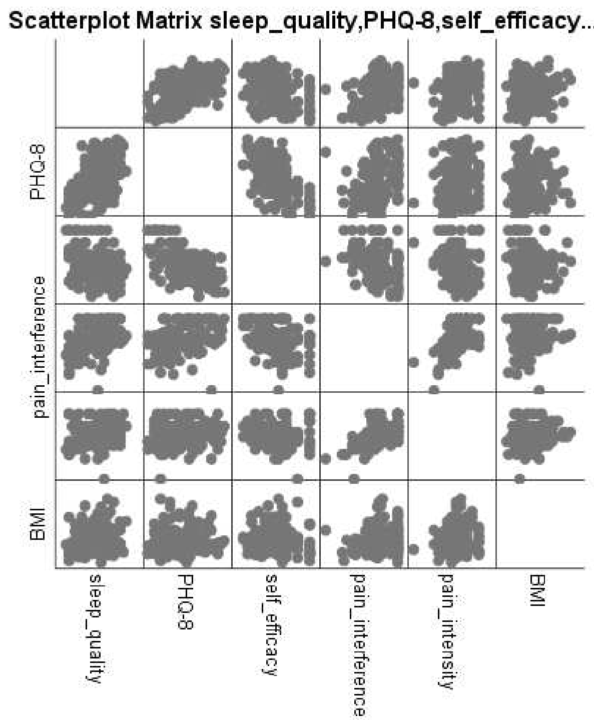

Figure 4.1. Scatterplot matrix of study variables of interest

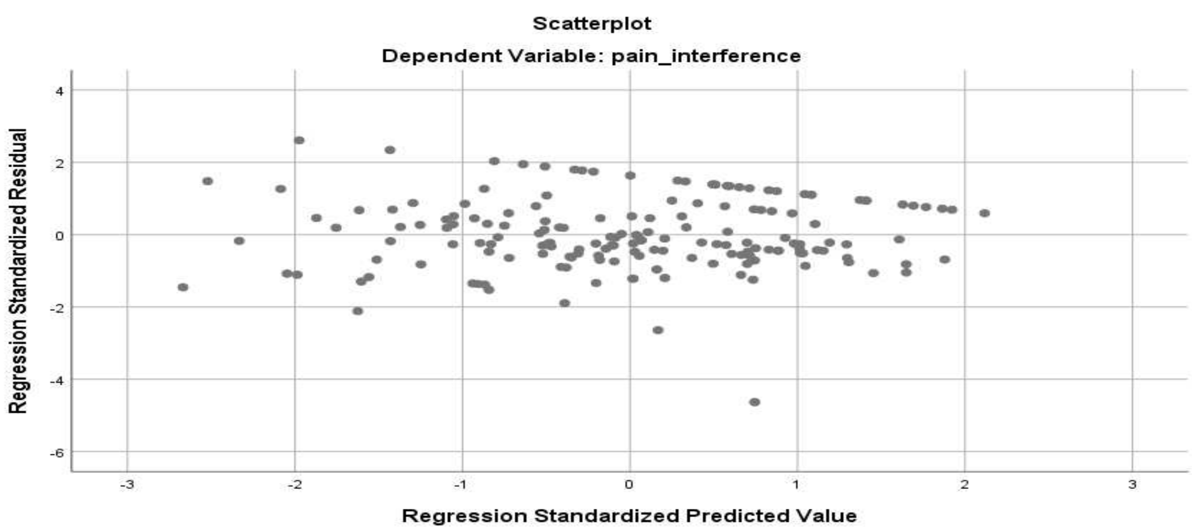

Figure 4.2 Residual scatterplot showing even distribution of pain interference outcome among all independent variables of interest

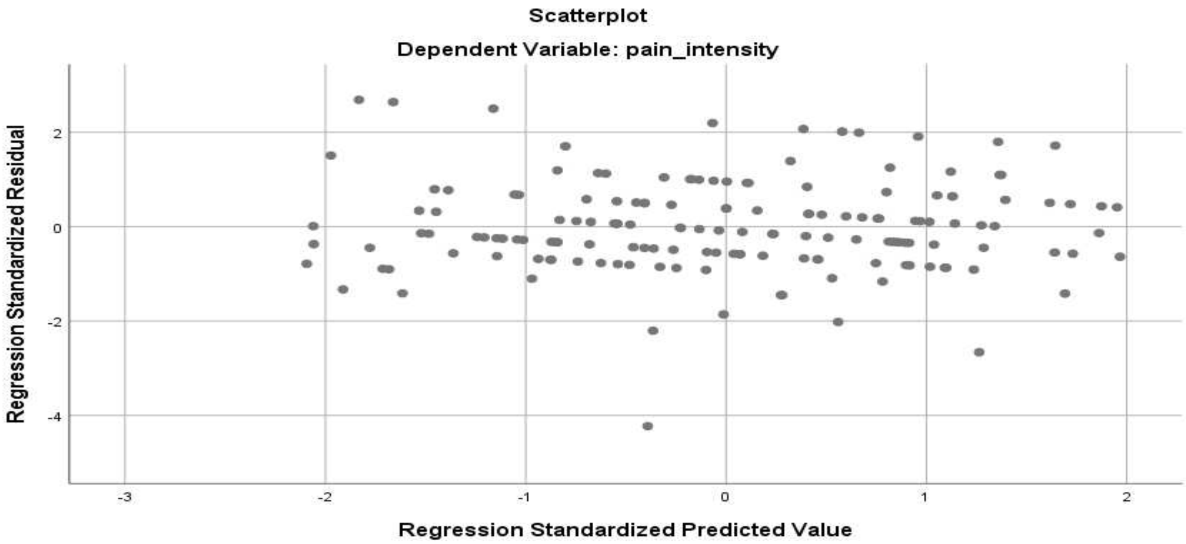

Figure 4.5 Residual scatterplot showing even distribution of pain intensity outcome among all independent variables of interest

Aim 1: Sample Description

The first aim of this study was to describe a sample of adults with a self-reported chronic pain condition who use prescription opioid medications daily. Out of a possible 300 cases available from the parent study, 233 adults self-reported a chronic pain condition and were included for analysis in this cross-sectional study. As mentioned above, due to the small number of adults who self-reported an underweight BMI (n=2.6%), the decision was made to add these cases to the recommended weight category for analyses. Demographics are displayed in Table 4.4 and are organized based on BMI category.

Mean scores of all variables of interest plus or minus the standard deviation were tabulated as seen in Table 4.1 above. Mean participant age was 48.55±14.7 years. Ages ranged from 19 years old to 85 years. Mean score on the PHQ-8 was 10.9±6.05, indicating a moderate level of depressive symptoms among the sample on average (Appendix A). Mean sleep quality score using the PSQI global score was 11.6±4.5, representing poor sleep quality on average (Appendix A). Mean BMI was 30.8±8.6, ranging from 14.7 to 62.7, demonstrating that the average BMI was in the obesity category among the group (Hales et al., 2017). Mean pain intensity t-score (see Appendix A for conversion table) on the PROMIS short form scale was 58.2±6.5, and similarly, mean pain interference t-score from the PROMIS 8-item scale was 66.9±6.8, indicating high levels of both pain intensity and pain interference. Mean self-efficacy scores were 44.5±7.7, indicative of a low average self-efficacy among the sample.

A logistic regression was performed to test the odds of group membership between adults with OUD versus adults with CP based on all health variables of interest. Using an ENTER technique, the overall model containing PSQI component score 1, total PHQ-8 scores, and total PROMIS scores for self-efficacy, pain intensity, and pain interference was significant (-2 Log likelihood=242.56, χ^2 (5)=31.61, p<0.001). The model was able to correctly classify 70.2% of cases. Variables able to significantly increase odds of being an adult with CP were worse sleep quality (e^B =1.35, p<0.05) and higher pain interference scores (e^B =1.10, p<0.01). Higher levels of depressive symptoms significantly predicted odds of being an adult with OUD (e^B =0.88, p<0.01). There was no significant difference between groups for all remaining variables. Refer to Table 4.4 below for confidence intervals for odds ratios for all variables.

Table 4.4 Logistic Regression Health Variable Coefficients

							95% CI	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Sleep Quality	.303	.131	5.316	1	.021	1.354	1.046	1.751
Depressive Symptoms	-.123	.034	13.217	1	.000	.884	.828	.945
Self-efficacy	-.008	.025	.103	1	.748	.992	.944	1.042
Pain Intensity	.004	.030	.014	1	.905	1.004	.947	1.063
Pain Interference	.097	.033	8.768	1	.003	1.101	1.033	1.174
Constant	-4.795	2.396	4.005	1	.045	.008		

Baseline Comparability. In the following section, various demographics findings and evidence for baseline comparability among the three weight categories will be presented.

Demographic Differences for Adults with Chronic Pain versus Opioid Use Disorder

Participants were included in the present study if using a prescription opioid and having a self-reported chronic pain condition. These criteria allowed for recruitment from two populations: one of adults being actively treated with opioid medications for opioid use disorder (OUD) and one of adults being actively treated with opioids to manage chronic pain (CP). Logistic regression analyses were conducted to compare demographic differences of age, gender, and BMI and health factor differences of sleep quality, depressive symptoms, self-efficacy, pain intensity, and pain interference among adults with OUD (N=84) compared to adults with CP (N=142). Adults with CP had significantly though minimally higher odds of having a higher BMI (p=0.02, CI 1.01 – 1.09) and of being older (p<0.001, CI 1.05 – 1.10) compared to those with OUD. Furthermore, adults with CP had greater odds for reporting worse sleep quality (p=0.02, CI 1.04 – 1.75) and higher pain interference (p<0.01, CI 1.03 – 1.17) and lower odds for reporting high levels of depressive symptoms (p<0.001, CI 0.83 – 0.95) compared to OUD. Chi-square analyses revealed significantly greater incidence of mental health diagnoses among OUD (64%) than among CP (41%, χ^2=11.5, p=0.001) and significantly more adults with OUD with less than a college degree (82%) compared to CP (56%, χ^2=14.4, p=0.013). Insignificant chi-tests were noted for differences among OUD and CP by income levels (χ^2=4.7, p=0.20), ethnicity (χ^2=2.9, p=0.58), and occupation (χ^2=14.4, p=0.17).

Demographic Differences Based on BMI

Potential differences in self-reported demographics of the sample based on BMI were evaluated through a series of bivariate and multivariate analyses. First, when applicable, t-tests were performed to test for differences in mean BMI (continuous) among gender, presence of a mental health condition, and among participant treatment center type (OUD versus CP). Mean BMI for males (n=75, m=29.0) was significantly different from mean BMI of females (n=150, m=31.2, t(-1.88), p=0.04). Mean BMI for adults with OUD treatment (n=84, m=28.6) was significantly different from mean BMI for those with CP treatment (n=142, m=31.5, t(-2.48), p<0.001). Mean BMI for adults with a mental health disorder (n=104, m=31.4) was not significantly different from mean BMI for those without (n=110, m=29.5, t(-1.67), p<0.10).

Next, a series of ANOVAs were conducted. BMI was entered as the continuous outcome variable and demographics of income, occupation, education, and ethnicity were entered as independent variables in four separate models. No significant differences in mean BMI were detected among groups by occupation (p=0.76), income (p=0.35), education (p=0.77), or ethnicity (p=0.85). Though not statistically significant, adults in the obese category had higher levels of being disabled or unemployed and reported the lowest annual incomes compared to those with overweight or recommended weight status. ANOVA's were conducted to test for differences in mean age and mean years of current prescription opioid use across BMI categories of recommended, overweight, and obese. No significant differences in mean age ($F_{2,225}$=0.28, p=0.76) or years of current prescription opioid use (p=0.9) were observed. See Table 4.5 below.

Table 4.5 Demographics of Adults with Chronic Pain by BMI Category

Demographic	**Recommended Weight (n= 65)**	**Overweight (n=72)**	**Obese (n=89)**
Gender			
Male	25/65 = 38.5%	26/72 = 36%	24/89 = 27%
Female	39/65 = 60%	46/72 = 64%	65/89 = 73%
Occupational Status			
Full-time	6/65 = 9.2%	12/72 = 16.7%	9/89 = 10.1%
Part-time	4/65 = 6.2%	5/72 = 6.9%	5/89 = 5.6%
Unemployed/Disabled	32/65 = 49.2%	34/72 = 47.2%	50/89 = 56.2%
Retired/Homemaker/Other	20/65 = 30.8%	19/72 = 26.4%	25/89 = 28.1%

Income			
< $20,000	33/65 = 50.8%	35/72 = 48.6%	53/89 = 59.6%
$20,000 - $39,000	9/65 = 13.8%	17/72 = 23.6%	9/72 = 10.1%
$40,000 -$79,000	10/65 = 15.4%	6/72 = 8.3%	12/89 = 13.5%
>$80,000	4/65 = 6.2%	5/72 = 6.9%	8/89 = 9.0%
Prefer not to say	7/65 = 10.8%	6/72 = 8.3%	7/89 = 7.9%
Participant Type			
Chronic Pain	37/65 = 56.9%	42/72 = 59%	63/89 = 70.8%
Opioid Use Disorder	28/65 = 43.1%	30/72 = 41%	26/89 = 29.2%
Age in Years (Mean ± SD)	48.3 ± 16.1	49 ± 14.8	47.5 ± 13.4
Mental Health Diagnosis			
None Reported	33/65 = 50.8%	36/72 = 50%	40/89 = 44.9%
Past or Current Reported	25/65 = 38.5%	33/72 = 45.8%	43/89 = 48.3%
Current Prescription Opioid Use in Years (Mean ± SD)	6.4 ± 6.3	5.9 ± 5.8	6.0 ± 5.6
Ethnicity			
American Indian/Alaska Native	4/65 = 6.2%	6/72 = 8.3%	6/89 = 6.7%
Asian	0/65 = 0%	1/72 = 1.4%	0/89 = 0%
Black or African American	0/65 = 0%	3/72 = 4.2%	2/89 = 2.2%
White	53/65 = 81.5%	53/72 = 73.6%	75/89 = 84.3%
Multiracial	5/65 = 7.7%	7/72 = 9.7	5/89 = 5.6%
Other	1/65 = 1.5%	1/72 = 1.4%	0/89 = 0%
Hispanic			
No	58/65 = 89.2%	63/72 = 87.5%	83/89 = 93.3%
Yes	4/65 = 6.2%	5/72 = 6.9%	4/89 = 4.5%
Education			
Less than Highschool	8/65 = 12.3%	7/72 = 9.7%	11/89 = 12.4%
Highschool or GED	19/65 = 29.2%	19/72 = 26.4%	16/89 = 18%
Some college/Associate's/Technical School	25/65 = 38.5%	39/72 = 54.1%	49/89 = 55.1%
Bachelor's	6/65 = 7.7%	4/72 = 5.6%	9/89 = 10.1%
Graduate Degree	5/65 = 3.1%	2/72 = 1.4%	3/89 = 3.4%
Marital Status			
Married/Living with partner	19/65 = 29.2%	28/72 = 38.8%	35/89 = 39.3%
Widowed	2/65 = 3.3%	6/72 = 8.3%	5/89 = 5.6%
Divorced/Separated	25/65 = 38.5%	24/72 = 33.3%	27/89 = 30.3%
Never married/Other	14/65 = 21.5%	12/72 = 16.7%	18/89 = 20.2%

*Note: missing data due to skipped question by participant accounts for instances where total percent does not equal 100%. *SD = Standard Deviation.*

Prevalence of Mental Health Conditions. The prevalence of mental health conditions in the sample was 48.2% (n=115), which varied by BMI status as demonstrated in Table 4.4. However, the risk for self-reporting a mental health diagnosis was not significantly different when comparing adults by weight category (p>0.05). Of those who reported a mental health condition, more than 45% described two or more diagnoses pertaining to mental health conditions. The most frequently reported condition was depression; 61.7% of the sample reported a diagnosis. The least commonly reported condition was schizophrenia or schizoaffective disorder with a 7% prevalence. The remaining frequency of conditions described by the sample were as follows: 21.7% reported an anxiety or panic disorder, 20% reported a Post-Traumatic Stress Disorder diagnosis, 17.4% reported a diagnosis of bipolar disorder, 7.8% reported an attention disorder, and 7.8% reported a personality disorder diagnosis. There were no cases of self-reported substance use disorder as a formal mental health diagnosis, despite 37.7% of the sample being recruited from OUD treatment centers. Of note, 64.2% of adults with OUD self-reported a mental health diagnosis, compared to 40.7% of adults with CP. Risk for an adult with OUD to self-report a mental health condition was significantly greater compared to an adult with CP (RR=1.58, $p<0.001$, CI 1.22 – 2.04).

Prevalence of Pain Conditions

Pain conditions self-reported by the sample are summarized in Table 4.5 below. The two most commonly reported chronic pain conditions were back pain and arthritis. Back pain was reported by 66% of recommended weight adults, 81% of adults with overweight status, and 83% of adults with obesity. Adults with BMI≥25 had a greater than 20% unadjusted risk of reporting back pain compared to adults with BMI<25 ($p=0.03$, CI 1.03 – 1.50). Arthritis was reported by 46% of adults with recommended weight, 47% of adults with overweight, and 68.5% of those with obesity. Adults with obesity, but not overweight status, had a statistically significantly increased risk for reporting a diagnosis of arthritis compared to adults with BMI<25 (RR=1.49, $p=0.01$, CI 1.10 – 2.00). The two least commonly reported chronic pain conditions were Complex Regional Pain Syndrome (CRPS; n =1.3%) and cancer-related pain (n=5.3%). Cancer is often related to weight loss, nausea, and lack of appetite (Sánchez-Lara, Ugalde-Morales, Motola-Kuba, & Green, 2013), and as anticipated in this sample, adults with a BMI<25 had more than three times the risk of reporting cancer-related chronic pain compared to adults with overweight or obesity (RR=3.47, *p*=0.03, CI 1.14 – 10.5). See figure 4.3 below for pain diagnosis categorization by weight status and Table 4.6 for the entire sample's reported prevalence of pain conditions.

Table 4.6 Sample Prevalence of Pain Conditions

Pain Type	**Prevalence**
Back Pain	77.00%
Arthritis	55.30%
Neck Pain	43.40%
Nerve Pain	36.70%
Migraines	25.20%
Other	24.70%
Post-surgical Pain	15.50%
Fibromyalgia	11.90%
Cancer Pain	5.30%
Complex Regional Pain Syndrome	1.30%

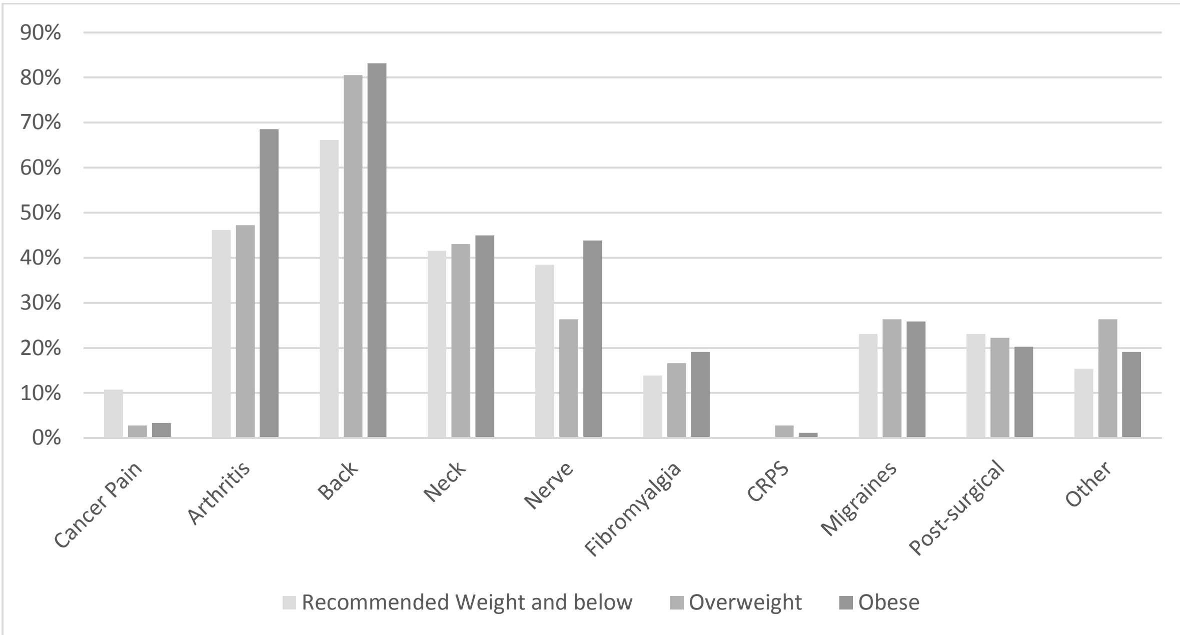

Figure 4.3. Prevalence of chronic pain conditions based on BMI category

Aim 2: Relationships between Pain and Weight

The second aim of the present study was to determine the relationships between BMI, pain intensity, and pain interference in the sample. A series of risk and odds ratios were conducted to better understand relationships between pain variables of pain intensity and pain interference and weight status as measured by body mass index. A risk or odds ratio is a useful epidemiological statistic to understand the prevalence of a certain outcome among comparison groups in a population. In this study, the main research purpose was to understand how weight status influences pain and other health outcomes. Thus, risk and odds ratio statistics were applied to understand differences in pain outcomes among adults with overweight and obese status compared to those with recommended weight status. To determine whether other pertinent health variables acted as effect modifiers or confounders on the relationship between pain outcomes and weight status, risk and odds ratios were conducted by stratifying groups of adults based on self-reported depression, sleep quality, and self-efficacy levels. The findings are reported below.

Pain Interference. A high pain interference level for this study was defined as a PROMIS pain interference t-score of 60 or greater. Adults with overweight status (BMI of 25 or greater) had more than double the odds (OR=2.67) and a higher risk for reporting a high pain interference level compared to recommended weight adults (RR=1.16, $p<0.05$, CI 1.01 – 1.33). When further stratifying groups by overweight status, it was discovered that obese status yielded a stronger risk for high self-reported pain interference than overweight. For adults with obese BMI versus recommended BMI, the average risk was 17% higher than recommended weight adults for reporting a high level of pain interference ($p<0.05$, CI 1.02 – 1.35). For adults with overweight (BMI 25 - 29.9), the risk was 13% greater to report a high pain interference level compared to recommended weight adults, though this value was not statistically significant at the 0.05 level ($p=0.06$, CI 0.98 - 1.31).

When comparing groups of overweight adults by stratification of all health variables of interest including sleep quality, depression, and self-efficacy, the risk was no different among adults with overweight compared to recommended weight status ($p>0.05$). Despite this finding, recommended weight adults on average reported lower levels for pain interference, pain intensity, and depression compared to adults with obesity. Refer to Table 4.7 below for the prevalence of favorable reports of each health variable dichotomized as outlined in chapter three of this dissertation and categorized by BMI group.

Table 4.7 Prevalence of Favorable Health Variable Outcomes by Weight Category

Weight Category	**Low Pain Interference**	**Low Pain Intensity**	**Low Depression**	**Good Sleep Quality**	**High Self-Efficacy**
Obese	7.87%	52.87%	41.18%	48.31%	24.14%
Overweight	11.11%	63.89%	38.02%	37.50%	19.72%

Recommended Weight	22.03%	55.17%	60.00%	41.54%	21.88%

Pain Intensity. A high level of pain intensity was defined as a PROMIS pain intensity t-score of 60 or greater. In this study sample, adults with overweight status (BMI of 25 or greater) had nearly the same odds and risk for reporting a high level of pain intensity compared to recommended weight adults. When further stratifying groups by overweight status, it was discovered that while obese status yielded slightly stronger risk and odds for high self-reported pain intensity than overweight when compared to recommended weight adults, these values were not statistically significant (p>0.05). When comparing groups of overweight adults by stratification of all health variables of interest including sleep quality, depression, and self-efficacy, the risk for reporting a high level of pain interference was no different for adults with overweight compared to recommended weight or below (p>0.05).

Aim 3: Relationships among all Variables

The third and final aim of the present study was to test the relationships between specific factors of sleep quality, depression, self-efficacy, pain intensity, pain interference and BMI in the sample. Bivariate relationships were explored first using Pearson's correlations and continuous variables. Thus, the PSQI global score was used to allow for calculation of the Pearson's correlation statistic. When substituting the ordinal variable of component score one for the PSQI global score to calculate Spearman's rho and increase the number of included cases, the relationships between poor sleep quality and other health variables did not change (data not shown). See correlation matrix in Table 4.8 below. Significant findings included the positive correlation between BMI and pain interference (r=0.16, p=0.01), such that self-reported pain interference scores increased significantly as BMI increased in the sample of adults with chronic pain conditions. There was no significant correlation observed between pain intensity and BMI (r=0.10, p>0.05).

Table 4.8 Bivariate Correlation Matrix

	PHQ-8	Pain Intensity	Pain Interference	BMI	Self-efficacy	Poor Sleep quality
Depression (PHQ-8)	1	$.250^{**}$	$.307^{**}$	0.004	$-.569^{**}$	$.507^{**}$
Pain Intensity		1	$.582^{**}$	0.093	$-.153^{*}$	$.255^{**}$
Pain Interference			1	$.163^{*}$	$-.305^{**}$	$.359^{**}$
BMI				1	-0.012	0.122
Self-efficacy					1	$-.349^{**}$
Poor Sleep quality						1

** = $p \leq 0.05$*
*** = $p \leq 0.01$*

Several significant Pearson correlations were demonstrated between both pain measures and all other health measures. As pain interference levels increased, so did levels of depressive symptoms (r=0.31, p<0.01), pain intensity (r=0.58, p <0.01), BMI (r=0.17, p <0.05) and poor sleep quality (r=0.36, p<0.01). Additionally, a negative correlation was demonstrated between pain interference and self-efficacy for symptom management, signifying that as pain interference levels increased, levels of self-efficacy for symptom management decreased (r=0.31, p<0.01). Similar positive correlations were found between pain intensity and depressive symptoms and poor sleep quality. A negative correlation was also present between pain intensity and self-efficacy for symptom management. See Table 4.5 for complete statistics.

A series of regression models were conducted to test multivariable relationships among all variables of interest. Afterward, to validate findings, internal validation procedures were executed by randomly splitting the file of adults with a self-reported pain condition and conducting multivariable analyses again. Additionally, external validation was tested by conducting multivariable analyses among the entire original sample (N=300) to compare adults with active treatment for opioid use disorder to those with active treatment for chronic pain. All results will be described in the following sections.

Impact of BMI on Relationship between Health Symptoms and Pain Variables. Several significant bivariate correlations were observed among all health factors and each pain variable though not with BMI. In order to understand the impact of BMI on the complex relationships between health factors and each pain outcome, step-wise regression analyses were conducted. Pain interference and pain intensity were tested as dependent outcomes in separate models. Results of multivariable regression models are described below.

Impact of BMI on Relationship between Health Symptoms and Pain Interference

Given the increasing body of knowledge suggesting a link between pain measurements and body weight status, an analysis was conducted to understand whether BMI significantly changed the relationship between pain interference and health symptoms known to be related to both weight status and pain among adults with chronic pain who regularly use prescribed opioid medications. This is a sensible approach as data suggest that BMI is a risk factor for chronic pain conditions such as osteoarthritis and may thus impact pain outcomes (Zheng & Chen, 2015). Independent variables were entered in the model in the following order: in the first block, depression, self-efficacy for symptom management, and sleep quality; in the second block BMI; in the final block, age and gender were added to control for both demographic variables. Findings demonstrated significant models at each step of blocking. The partial correlations of each health variable of interest were significant in each step even when controlling for age and gender as seen in Table 4.9 below. The variable that had the greatest unstandardized Beta weight in the overall model was sleep quality as seen in Table 4.7 (B=1.27, t_{216}=3.73, p<0.001).

Table 4.9 Coefficient Relationships of Variables with Pain Interference at Final Analysis Step

	B	Std. Error	t	Sig.
(Constant)	60.663	4.331	14.008	0.000
Self-efficacy	-0.150	0.067	-2.236	0.026
Depression	0.240	0.085	2.835	0.005
Sleep quality	1.268	0.340	3.734	0.000
BMI	0.130	0.048	2.677	0.008
Age	0.086	0.030	2.893	0.004
Gender	0.062	0.066	0.941	0.348

BMI acted as an effect modifier in the regression model, significantly increasing the strength of the relationships between health symptoms and pain interference. When adding BMI into the model, the explanation of the variance in pain interference was significantly increased by 2.1% and the overall model including BMI accounted for 17.5% of variance (R^2=0.19, R^2_{adj}=0.175, $F_{4,216}$=12.45, p<0.001). Table 4.10 below shows the significant increase in the strength of relationship between pain interference and other health variables when accounting for the individual impact of BMI in model two. See figure 4.6 below for a representation of the increase in BMI and other health variables as pain interference increases. The final regression equation demonstrating the relationship of all health variables tested is:

$$\textit{Pain interference} = 60.66 - 0.15X_{\text{self-efficacy}} + 0.24X_{\text{depression}} + 1.27X_{\text{sleep quality}} + 0.13_{\text{BMI}}$$

Table 4.10 BMI Significantly Increases Model Prediction of Pain Interference among Adults with Self-reported CP

Model	Adjusted R Square	R Square Change	F Change	df1	df2	Sig. F Change
1	0.158	0.169	14.474	3	213	0.000
2	0.175	0.021	5.461	1	212	0.020
3	0.209	0.041	5.558	2	210	0.004

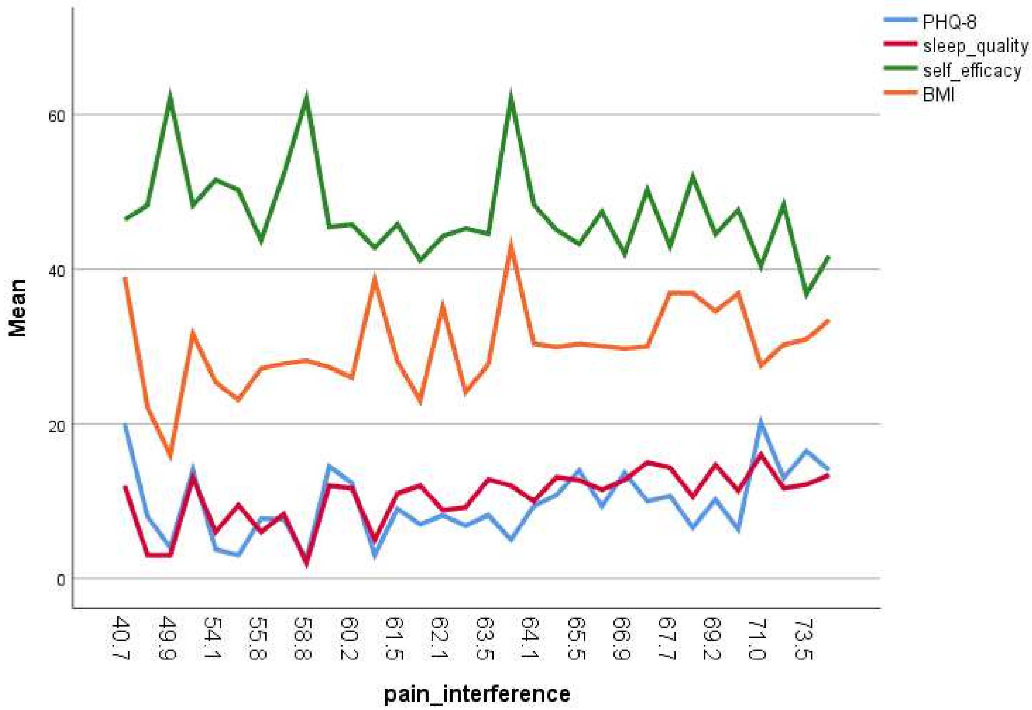

Figure 4.6 Relationship of BMI to pain interference in context of other health variables

Impact of BMI on Relationship between Health Symptoms and Pain Intensity

As described in the preceding section, multivariable analyses were conducted once more using pain intensity as the dependent variable to understand the impact of BMI on relationships between pain intensity and other health variables. The model was run in the same fashion described above for the outcome of pain interference. BMI was not found to significantly act as an effect modifier on the relationships between pain intensity and depression, sleep quality, and self-efficacy. The final model controlling for age and gender, however, was significant and explained 8.5% of the variance in pain intensity (R^2=0.112, R^2_{adj}=0.085, $F_{6,202}$=4.10, p=0.001) with sleep quality emerging as the strongest variable explaining pain intensity (B=0.77, t_{216}=3.73, p<0.05). See Table 4.11 below for the individual significance of each variable in explaining the variance in pain intensity. Of note, contrary to findings when examining pain interference as the outcome, neither BMI nor self-efficacy for symptom management played a significant role in explaining multivariable relationships in the final model.

Table 4.11 Coefficient Relationships of Variables with Pain Intensity

	B	Std. Error	t	Sig.
(Constant)	52.434	4.604	11.388	0
Depression	0.222	0.09	2.466	0.015
Self-efficacy	-0.019	0.071	-0.265	0.792
Sleep quality	0.774	0.361	2.145	0.033
BMI	0.062	0.05	1.242	0.216
Age	0.014	0.031	0.435	0.664
Gender	0.179	0.067	2.666	0.008

Internal Validation. Internal validation procedures were undertaken to further validate multivariable study findings. Internal validity was executed by randomly splitting the file of adults with a self-reported pain diagnosis in half and conducting multivariable regression models to ascertain whether similar findings would be achieved. Internal validation was only performed using pain interference and pain intensity as outcomes given the poor fit model produced when using BMI as the outcome variable.

Internal Validity for Pain Interference

Findings for the impact of BMI on the relationship between pain interference and depression, sleep quality, and self-efficacy for symptom management were similar on a randomly selected sample of adults with a self-reported pain condition as they were for the entire sample of those with a pain condition. In this model of n=110, the addition of BMI significantly strengthened the relationship between pain interference and other health symptoms. A total of 16.4% of the variance was explained by BMI plus the three other variables (R^2=0.194, R^2_{adj}=0.164, $F_{4,110}$=4.10, p<0.001), compared to 14.6% in the absence of BMI. However, when controlling for age and gender, BMI was no longer able to independently account for the variance in pain interference (β=0.094, t=1.46, p>0.05). Thus, despite the loss of significance of BMI when adjusting for age and gender, internal validity was generally demonstrated when examining multivariable relationships between all health symptoms of interest and pain interference in this sample.

Internal Validity for Pain Intensity

When randomly splitting the file between all adults with a self-reported chronic pain diagnosis and examining relationships between health symptoms and pain intensity, findings were different compared to analysis using the entire sample of adults with a pain condition. Upon randomly splitting the file, the sample size decreased to 142 cases. All models reached significance at the $p \leq 0.001$ level. Depression ($p \leq 0.01$) and sleep quality ($p \leq 0.05$) both independently explained pain intensity and sleep quality was the strongest variable. See Table 4.12 below for statistics. Thus, internal validity was able to be demonstrated when examining multivariable relationships between health symptoms and pain intensity in this sample.

Table 4.12 Coefficient Relationships with Pain Intensity among Random Sample of Adults with CP

	B	Std. Error	t	Sig.
(Constant)	35.472	5.773	6.144	0
Depression	0.423	0.122	2.546	0.001
Self-efficacy	0.152	0.088	1.722	0.087
Sleep quality	1.200	0.473	2.536	0.012
BMI	0.064	0.073	0.880	0.380
Age	0.082	0.039	2.098	0.038
Gender	1.480	1.223	0.098	0.228

External Validation. In order to externally validate the findings of the multivariable analyses, regression models were re-conducted among adults being actively treated for chronic pain and adults receiving active treatment for opioid use disorder. Analysis of multivariable relationships was patterned after internal validation procedures as above. Regression models were first conducted using pain interference as the outcome for adults with chronic pain treatment and again for adults with opioid use disorder treatment. Models were also conducted separately for both populations with pain intensity as the outcome.

External Validity for Pain Interference

Among adults with active treatment for CP, findings for the multivariable analyses differed from those demonstrated when using the sample of all adults with a pain diagnosis. The presence of BMI increased the strength of the model from 23.9% to 24.1%, however, this change was not statistically significant ($F_{1,134}$=1.30, p>0.05). In the final model controlling for age and gender, the variables able to significantly explain the outcome of pain interference were depression (B=0.349, t_{134}=3.52, p=0.001), sleep quality (B=0.858, t_{134}=2.17, p<0.05), and gender (B=2.691, t_{134}=2.67, p<0.01), though not BMI or self-efficacy. Sleep quality was not individually significant in explaining pain interference until accounting for the presence of age and gender. Each step of the model reached statistical significance, with the final model predicting 27% of the variance (R^2=0.302, R^2_{adj}=0.270, $F_{6,138}$=9.52, p<0.001).

For adults with active treatment for OUD, results of multivariable regression analyses were similar when compared to adults with a self-reported pain diagnosis though different from the sample of adults in active CP treatment described above. While the addition of BMI in the second block increased the model fit from 17.8% to 19.2%, this change was not statistically significant at the p≤0.05 level. Furthermore, the individual effect of BMI was not significant in the model until controlling for age and gender in the final step (β=0.212, t=2.00, p<0.05). Additionally, sleep quality and self-efficacy were not significant independent predictors of pain interference at the final step of the model. Each step of the model reached statistical significance, with the final model accounting for the largest percentage of variance (R^2=0.251, R^2_{adj}=0.217, $F_{6,85}$=7.33, p<0.001). See Table 4.13 below for a summary of coefficient relationships with pain interference. Thus, external validity was not achieved when examining multivariable relationships between health symptoms and pain interference among adults with active CP treatment compared to adults with active OUD treatment.

Table 4.13 Coefficient Relationships with Pain Interference among Adults with Treatment for OUD

	B	Std. Error	t	Sig.
(Constant)	50.975	5.595	9.111	0
Sleep quality	1.035	0.58	1.785	0.077
Depression	0.431	0.13	3.31	0.001
Self-efficacy	-0.109	0.093	-1.179	0.24
BMI	0.212	0.106	1.997	0.048
Age	0.094	0.055	1.71	0.09
Gender	0.092	0.088	1.047	0.297

External Validity for Pain Intensity

Findings for adults with active treatment for chronic pain followed the same pattern observed when conducting analyses among all adults with a self-reported pain condition. As described prior, BMI, sleep quality, and self-efficacy were not significant contributors to explaining variance in pain intensity, though overall models did reach significance at each step of analysis. In the final model controlling for age and gender, over 17% of the variance of pain intensity was explained by health symptoms and BMI (R^2=0.213, R^2_{adj}=0.175, $F_{6,129}$=5.55, p<0.001). See Table 4.14 below for coefficient relationships with pain intensity.

Table 4.14 Coefficient Relationships with Pain Intensity among Adults Treatment for CP

	B	Std. Error	t	Sig.
(Constant)	54.205	5.297	10.233	0.000
Sleep Quality	0.663	0.387	1.715	0.089
Depression	0.295	0.097	3.031	0.003
Self-efficacy	0.038	0.078	0.488	0.627
BMI	0.018	0.048	0.377	0.707
Age	-0.081	0.033	-2.442	0.016
Gender	1.427	0.983	1.452	0.149

Findings for adults with active treatment for OUD exhibited stronger relationships between depression and pain intensity than observed among adults with active CP treatment as seen in the final step of analysis ($\beta = 0.386$, t=2.84, p<0.01). While models remained significant at each step of analysis, self-efficacy, BMI, and sleep quality were unable to significantly and independently predict pain intensity at any point (p>0.05). The final model controlling for age and gender accounted for more than 20% of the variance in pain intensity (R^2=0.287, R^2_{adj}=0.253, $F_{6,84}$=8.39, p<0.001). See Table 4.15 below for individual impacts of variables on the outcome of pain intensity with depression emerging as the strongest and only health factor explaining pain intensity. As with pain interference above, external validation was unable to be completely demonstrated when assessing pain intensity in the context of health symptoms among this sample of adults with CP treatment and adults with OUD treatment.

Table 4.15 Coefficient Relationships with Pain Intensity among Adults with Treatment for OUD

	B	Std. Error	t	Sig.
(Constant)	38.004	5.744	6.616	0
Sleep quality	0.403	0.605	0.665	0.507
Depression	0.386	0.136	2.838	0.005
Self-efficacy	-0.082	0.095	-0.859	0.392
BMI	0.145	0.11	1.322	0.189
Age	0.258	0.056	4.616	0
Gender	0.094	0.089	1.056	0.293

Summary

Many bivariate and multivariable relationships were observed between all variables of interest. An overweight or obese BMI significantly increased the risk for a high level of pain interference in a dose-dependent relationship in this sample. The same risk was not present for adults with overweight or obese status to report high levels of pain intensity compared to adults with recommended weight status or below. Pearson's correlation coefficient calculations found a significant and positive correlation between pain interference and BMI, though BMI was not significantly correlated with any other health variables of interest. Notwithstanding, BMI was found to positively and significantly strengthen relationships between depression, self-efficacy, sleep quality, and pain interference among adults with a self-reported chronic pain diagnosis who regularly use prescription opioid medications. The finding was validated through internal though not external validation procedures. In contrast, BMI was not found to significantly change relationships between the latter health symptoms and pain intensity, a result that remained consistent throughout internal and external validation analyses.

CHAPTER FIVE

DISCUSSION AND CONCLUSIONS

Within this chapter, results of the current study are discussed in the context of the existing research literature and interpreted using the chosen theoretical framework, the IFSMT. Implications for education and clinical practice are detailed. Future research directions in this line of study are described, and study strengths and limitations are presented.

Key Research Findings

The aim of the current study was to determine relationships between pain outcomes of pain interference and pain intensity and health factors of self-efficacy for symptom management, depressive symptoms, sleep quality, and overweight status. Several key findings emerged from this secondary analysis. Significant results included: 1) of the sample, adults taking opioid medications who had a higher mean BMI were more likely to be female and recruited from chronic pain (CP) treatment centers compared to opioid use disorder (OUD) treatment centers, 2) adults with higher BMI had a greater risk for having a diagnosis of back pain and arthritis and lower risk of suffering cancer-related pain, 3) nearly half the sample reported a mental health diagnosis, with major depression being the most common, 4) overweight or obese status significantly increased risk for high levels of self-reported pain interference but not pain intensity, 5) increasing levels of pain interference significantly predicted higher BMI, and 6) BMI acted as a significant effect modifier of the relationship between all health symptoms and pain interference but not pain intensity. Findings of significant multivariable analyses were not completely supported through internal or external validation analyses in terms of relationships between weight status and pain outcomes. Major findings will be presented by specific aim below. Results will be discussed in the context of pertinent research literature.

Specific Aim #1: Characteristics of the Sample

The first specific aim was to describe the demographics and health characteristics of the sampled population of adults with chronic pain taking prescribed opioid medications. Several noteworthy findings emerged. Results will be described below, beginning with demographics and ending with health variables.

Demographic Findings

In terms of demographic results, several variables were measured and are reported here. Among all surveyed adults, those receiving active treatment for chronic pain and females had a significantly higher mean BMI than those receiving treatment for opioid use disorder and males. Adults with active treatment for opioid use disorder have been found to gain weight and increase BMI category over time independent of maintenance opioid dose (Peles, Schreiber, Sason, & Adelson, 2016) which has been most strongly associated with female gender (Fenn, Laurent, & Sigmon, 2015). In the current study, mean age for adults with active treatment of opioid use disorder was 41±13.0 years and for adults with active chronic pain treatment was 52±13.9 years which was significantly different when tested in a logistic regression ($B=0.07$, $e^B=1.07$, $p<0.001$), though age did not differ across BMI categories for the sample ($F_{2,225}=0.28$, $p=0.76$). Increasing age and female gender have both been associated with higher BMI in the United States (Wang, & Beydoun, 2007). Thus, the findings that the younger population of OUD adults had a lower average BMI than the older population of adults with CP and that females had a higher BMI than males are both in line with current literature.

In the present study sample, 80.1%, reported a Caucasian race, 7.5% reported a multiracial status, 7.1% reported American Indian/Alaskan Native race, 5.8% of the sample reported a Hispanic ethnicity, 2.2% reported an African American background, and less than

0.5% reported an Asian race. According to the US Census Bureau (2017), in Spokane, WA, the majority of the population is Caucasian (81%), followed by multiracial (6%), Asian (3%), Black (2%), and Native (1%). The remaining 6% of the population reports a Hispanic ethnicity. Thus, the study sample is representative of the population in the surveyed geographic area in terms of participant self-reported ethnicity and race. There were no differences in ethnicity or race based on weight status or treatment for OUD versus CP. A recent prevalence study also estimated no differences in reports of chronic pain among ethnicities, other than slightly lower odds for Hispanic adults to report pain than non-Hispanic or Black adults (Hardt et al., 2008). Prevalence estimates investigating chronic pain among adults with OUD found that Caucasians were more likely than African-Americans or Hispanics to report a pain condition (Rosenblum et al., 2003). Neither study explored whether BMI differed by ethnicity among those with chronic pain. Thus, while the current study demonstrates a representative sample of the geographic region surveyed, further studies with more diverse populations may be needed.

Other demographic variables of the sample included education level, annual income, employment status, presence of a mental health condition, and number of years taking current prescription opioid medication. There were no differences in any of these variables by weight status. Most of the sample reported an education level of “some college” or less. Greater than 50% of the sample reported an annual income of less than $20,000 per year, indicative of living below the federal poverty line (Healthcare.gov, 2018). Less than 40% of the sample reported being married or living with a partner. Greater than 75% of the sample reported no current work due to disability, retirement status, or other. A recent prevalence study found that the odds of having a chronic pain diagnosis were highest among adults with the lowest income status, those who were divorced or separated, and those without a college degree (Johannes et al., 2010). A large survey of adults in Europe found greater than 60% adults with chronic pain reported significantly decreased or complete inability to work related to the chronic pain condition (Breivik et al., 2006). On average, adults in the sample reported taking current prescription opioid for 6 years, ranging from recent therapy initiation to 29 years. Longitudinal studies suggest that long-term opioid prescription, defined as daily use exceeding 3 months, is becoming more prevalent among adults with chronic pain in the US (Campbell et al., 2010). Thus, the present study sample appears to be representative of adults with chronic pain.

Two demographics were found to differ significantly between adults recruited from OUD centers compared to CP centers. The first was prevalence of mental health disorders and the second was education level. Adults from OUD centers had higher prevalence of mental health disorders (64% compared to 41%) and lower education levels (82% less than college degree compared to 57%) compared to CP. Research suggests a higher incidence of opioid use disorder among adults with a mental health diagnosis (Sullivan et al., 2006). Furthermore, evidence supports that presence of a mental health disorder among adults with chronic pain may increase risk for high-risk patterns of opioid use such as seeking early refills (Seal et al., 2012). Recent studies show that having less than a college education may increase risk for having an opioid use disorder (Martins et al., 2015) and that regular opioid use may increase with decreasing education level across adults in the US (Kelly et al., 2008). These findings illustrate the need to identify and treat mental health disorders among adults with chronic pain, especially if in treatment for OUD, and to promote educational achievement to reduce risky opioid use patterns.

Health Characteristics

All health variable scores are presented in chapter 4 of this dissertation. The average scores on all health-related measures were higher in the present sample than those noted in populations without chronic pain and will be described below. Each variable will be discussed in the following section with implications for translation of findings to practice briefly proposed.

Depression. The mean score on the PHQ-8 was 10.9±6.05, indicating on average higher levels of depressive symptoms in this group as compared to another study of adults with chronic conditions who scored a mean of 6.7±5.5 on the scale (Ory et al., 2013). Prior studies indicate that when assessing for depression among adults with chronic illness, a score of 10 or greater on the PHQ-8 is sensitive for a diagnosis of depression (Pettersson, Bengtsson, Gustavsson, & Ekselius, 2015). See Appendix A for a detailed summary of how to score the PHQ-8. Briefly, a score between 10 - 14 on the scale is indicative of moderate levels of depression. Thus, on average, adults in this study reported at least moderate levels of depression.

Significant differences were seen when comparing mean depressive symptom scores among adults with OUD and adults with CP. Adults with OUD (N=86) had a mean PHQ-8 score of 12.4±9.4, compared to adults with CP (N=145) who had a mean score of 10.1±6.0. According to the logistic regression reported in chapter 4, adults with CP had 12% less odds than adults with OUD to report a higher PHQ-8 score. Thus, the burden of depression appears to be slightly greater in adults with OUD compared to CP within the greater population of adults with chronic pain using prescription opioids. Treatment of depression has been shown to improve pain and weight outcomes among adults with CP who have overweight status (Somers et al., 2012). Clinicians therefore may need to be more proactive in screening for and subsequently treating depression among adults with OUD compared to those without when managing pain outcomes among adults with a chronic pain condition.

Sleep quality. Mean sleep quality score using the PSQI global score was 11.6±4.5, representing poor sleep quality on average given that a score of seven or greater has been recommended to determine poor sleep quality among adults with chronic low back pain (Alsaadi et al., 2013). Significant differences were seen when comparing mean sleep quality scores among adults with OUD and adults with CP. Adults with CP had 35% greater odds of reporting worse sleep quality as compared to adults with OUD. Average PSQI global scores for adults with OUD (N=60) was 10.9±4.5 which was a lower mean in contrast to that observed among those with CP (N=114, m=11.9±4.6). Sleep has been previously found to be impaired among adults with CP, especially in the context of co-occurring overweight status (Okifuji et al., 2010). Poor sleep quality has also been observed among adults with OUD (Ara et al., 2016). Weight loss among women with chronic pain has been shown to significantly improve sleep quality scores (Shade et al., 2016). Thus, knowing that adults with chronic pain taking prescription opioid medications who do not have OUD may suffer worse sleep quality could help guide clinicians in screening for and treating poor sleep quality.

Self-efficacy. On average, self-efficacy for symptom management scores were lower than the general population. There were no differences in mean self-efficacy scores computed by logistic regression (p>0.05). Average scores on the PROMIS scale for self-efficacy among adults with OUD (N=84) was 43.8±8.1 and for adults with CP (N=145) was 45.0±7.5. Though there was no difference in mean scores between groups, the average score was nearly one standard deviation below the mean reported by the general population for self-efficacy (NIH, 2015). The low average self-efficacy score indicates that for this sample of adults with chronic pain who use prescription opioids, individuals possess little confidence in personal ability to self-manage symptoms related to chronic pain. Prior studies indicate that self-efficacy may support improvements in pain (Rooij et al., 2013) and weight outcomes (Knerr, Bowen, Beresford, & Wang, 2016). Future studies should test interventions that increase self-efficacy among populations of adults with chronic pain who use prescription opioid medications to determine whether improvements in pain and weight outcomes are observed in the short and long-term.

BMI. Mean BMI in the present study was 30.8±8.6, ranging from 14.7 to 62.7, demonstrating that the average BMI was in the obesity category among the group (Hales et al., 2017). Mean BMI among adults with chronic pain has been measured to be in the overweight versus obese category in several studies (Chou et al., 2016; Eslami et al., 2016; Fowler-Brown et al., 2013; Morasco et al., 2014; Pells et al., 2005; Ray et al., 2010). The present finding that adults in this sample, in contrast, have a mean BMI in the obese category could implicate that among a group of adults with chronic pain using opioid medications, prevalence of obesity is higher than among adults with chronic pain who may not be regularly taking prescription opioids. However, in a sample of Veterans, no relationship was found between BMI for those with chronic pain taking opioid medications, those with chronic pain not taking opioids, and those without chronic pain or opioids (Morasco et al., 2014). Further research may be required to determine if differences in BMI exist between adults with CP taking prescription opioids and those without opioid consumption. BMI outcomes are compared between adults with OUD and CP in the demographic section below.

Pain intensity and pain interference. Mean pain outcomes were both higher than measured in the general population for this sample. The average pain intensity t-score (converted from raw score; see Appendix A for conversion table) on the PROMIS short form scale was 58.2±6.5, indicating higher pain intensity levels in this sample than reported among an average, healthy population (Chen et al., 2012). The mean pain interference t-score from the PROMIS 8-item scale was 66.9±6.8, exhibiting that a higher pain interference average score was calculated among this sample as compared to general well populations (Amtmann et al., 2010). Significant differences were seen when comparing mean pain interference scores among adults with OUD and adults with CP, but not when comparing pain intensity scores. In terms of pain interference, adults with OUD (N=86), had a mean score of 64.7±7.1 and adults with CP (N=145) had a mean score of 67.9±6.3. As reported in chapter 4, adults with CP had 10% greater odds of reporting high levels of pain interference compared to adults with OUD. For pain intensity, adults with OUD (N=79) had a mean score of 57.0±7.6 and adults with CP (N=136) had a mean of 58.6±5.6. Clinicians may therefore benefit from targeting pain interference outcomes among adults with chronic pain using prescription opioids, especially in the absence of OUD.

Risk for pain based on weight status. In the present sample, adults in the overweight and obese category had a higher risk for self-reporting a chronic pain diagnosis of back pain or arthritis compared to adults with recommended weight status and a lower risk for reporting cancer-related pain as reported in chapter four of this dissertation. Of note, the prevalence of cancer-related pain was reported to be small in the sample (n=5.3%) compared to reported rates of back pain (n=77%) and arthritis (n=55.3%). A previous meta-analysis found that risk for chronic low back pain was higher among adults with overweight status and even higher among adults with obesity compared to those with recommended weight status (Shiri et al., 2007). A recent population study conducted in Canada found that over a 15-year period, increasing levels of BMI continued to increase risk for arthritis (Badley, Canizares, & Perruccio, 2017), thus supporting the finding in this study. Cancer is often treated with chemotherapy drugs which have major side effects including nausea, vomiting, and weight loss (Sanchez-Lara et al., 2013). Thus, this study provides support for the negative association between BMI and cancer-related pain.

Mental health characteristics. Nearly half of the surveyed sample reported a mental health diagnosis (n=48.2%). The most commonly reported mental health condition was depression, with anxiety and PTSD following behind. A recent Veteran study found that 51% of 141,029 adults who received a pain diagnosis were also diagnosed with at least one mental health condition (Seal et al., 2012). In the United States today, it is estimated that mental illness affects 18.5% of adults (National Alliance on Mental Illness, 2018), exhibited a higher prevalence of mental health conditions in the study sample compared to the general population. Much evidence exists to support that having a mental health condition such as depression increases likelihood of having a chronic pain condition (Chou et al., 2016; Nicholl et al., 2015; Ohayon & Stingl, 2012; Wright et al., 2010). In addition, studies suggest that worse pain outcomes are observed if an adult suffers both a mental health condition and chronic pain (Marcus, 2004; Mundal et a., 2014; Probst et al., 2016; De Rooij et al., 2013; Tietjen et al., 2007). Thus, the burden of mental illness is much higher among adults with a chronic pain diagnosis than among those without a pain condition, and presence of both conditions can negatively impact pain outcomes.

Mental illness has also been found to be related to BMI among adults both with and without chronic pain. A qualitative study conducted among adults with chronic pain and overweight or obesity found that eating in the absence of hunger was triggered by feelings of depression and pain and a low self-efficacy for physical activity (Janke & Kozak, 2012). In a cross-sectional study conducted on adults with chronic pain, depressive symptoms were found to dose-dependently increase based on BMI, where adults with obesity reported significantly higher levels of depressive symptoms than those with overweight or recommended weight BMI (Marcus, 2004). Among adults with chronic pain related to persistent migraines, increasing levels of BMI were dose-dependently associated with increasing levels of depressive and anxiety symptoms (Tietjen et al., 2007). A meta-analysis of longitudinal studies supported a relationship between depression and obesity in the general population (Blaine, 2008). A review study on the relationships between chronic pain and obesity offers behavioral abnormalities as a potential mechanism for association, citing several studies linking obesity to depression, eating disorders, and fear of physical activity (Narouze & Souzdalnitski, 2015). Higher levels of depression increased risk for reporting severe pain, and severe levels of pain were a significant barrier to weight loss among adults with chronic pain and overweight status engaged in a weight loss trial (Masheb et al., 2015), also suggesting a relationship between mood, pain, and weight.

Specific Aim #2: Risk and Odds of Pain among Adults with Overweight or Obesity

The second specific aim of the present study was to calculate whether adults with overweight or obesity had higher risk and odds of reporting high levels of pain intensity and pain interference compared to adults with recommended weight status. Adults with overweight or obesity compared to those with recommended weight had significantly higher risk and odds of reporting high levels of pain interference ($p<0.05$). The same was not true when comparing groups for risk of high levels of pain intensity. Discussion of the results in the context of existing research will be presented below.

Pain Interference. Pain interference is a concept measuring the amount to which pain interrupts one's ability to physically, emotionally, and socially engage in everyday activities (Haefeli & Elfering, 2006) including activities of daily living or sleep (NIH, 2015b). Higher BMI is associated with poorer sleep (Cappucio et al., 2008), poorer mood (deWit et al., 2010), and decreased physical activity levels (Knerr, Bowen, Beresford, & Wang, 2016). Thus, it would logically follow that increasing levels of pain interference might be impacted by a higher BMI. As hypothesized, among the surveyed sample of adults with self-reported chronic pain taking prescription opioid medications, an overweight or obese BMI significantly increased risk and odds of higher levels of pain interference. Because there are many components of pain interference including emotional and physical symptoms (Wilson, 2014), it would be pertinent for future research to investigate what kind of interference is most important for weight status and whether there are gender or age-related influences to allow for targeted treatment interventions.

Much research supports that higher pain interference levels are significantly related to higher BMI (Allen et al., 2016; Chou et al., 2016; Marcus 2004; Jacobsson, 2010; Pells et al., 2005; Urquhart et al., 2011). However, some researchers performing cross-sectional work were unable to find a link between weight status and pain interference among men (Fowler-Brown et al., 2013) or military veterans (Godfrey et al., 2018). Thus, the finding that pain interference and BMI were significantly related among the presently sampled male and female adults with chronic pain taking opioid medications aligns with some existing research.

Pain Intensity. Pain intensity, or pain severity, is a concept measuring the degree to which pain is experienced at any given time as well as during a specific time frame. Pain intensity is considered a unidimensional measure of pain, compared to pain interference which is considered a multi-dimensional measure of pain (Younger et al., 2009). Research is much less clear when comparing weight status to pain intensity as opposed to weight status and pain interference. Studies show that levels of pro-inflammatory factors such as interleukin-6 and tumor necrosis factor-α increase with increasing levels of pain intensity in participants with chronic pain compared to healthy controls (Koch et al., 2007) as well as in adults with acute, surgical-related pain (Wang, Hamza, Wu, & Dionne, 2009). Overweight status and obesity are also highly correlated with pro-inflammatory processes (Saltiel, & Olefsky, 2017) even in the context of co-occurring overweight status and chronic pain (Bondakar, 2013). As such, it was hypothesized that increasing levels of BMI would increase pain intensity levels among adults with chronic pain taking prescription opioid medications.

In contrast to study hypotheses, overweight or obese BMI did not significantly increase risk or odds of higher levels of pain intensity compared to adults with recommended weight. Several studies among adults with chronic pain also failed to find a significant relationship between pain intensity and weight status (Fowler-Brown et al., 2013; Godfrey et al., 2018; Marcus, 2004; Pells et al., 2005). However, other studies were able to find a signficant relationship. For example, higher BMI was associated with higher pain intensity among adults with fibromyalgia (Okijuji et al., 2010) and in population studies assessing older adults (Eslami et al., 2016), as well as men (Chou et al., 2016; Urquhart et al., 2016) with and without chronic pain conditions. Weight loss among adults with overweight status chronic pain was also found to reduce pain intensity among adults with arthritis (Messier et al., 2013; Somers et al., 2012) and chronic back pain (Vincent et al., 2014). However, severe levels of pain intensity were found to be a barrier to weight loss among adults with co-occurring chronic pain and overweight status (Masheb et al., 2015; Ryan et al., 2017). Given that pain intensity measures only the degree of pain experienced at a given point in time, it may be more clinically meaningful to focus on the multi-dimensional measure of pain interference in the context of obesity as both conditions are influenced by measures of mood (Tietjen et al., 2007), sleep (Mork et al., 2013), and physical functioning (Foy et al., 2011).

In the present study, risk for arthritis and chronic back pain were significantly higher among adults with obesity compared to recommended weight status. Higher weight status did not increase risk for other reported pain conditions. One possible explanation may be that not all chronic pain conditions are influenced by BMI among adults regularly taking prescription opioid medications. However, prevalence of other reported pain conditions was relatively low which could demonstrate a need for larger sample sizes to determine if there is a significant relationship. Future research should focus on determining relationships between weight status and risk for any type of pain condition among adults who take prescription opioids to help guide clinician recommendations for adults at risk for developing chronic pain.

Specific Aim #3: Relationships between all Health Factors in the Sample

The third and final aim of the current study was to determine relationships between all health factors of depression, sleep quality, self-efficacy for symptom management, weight status, pain intensity, and pain interference. The analytic plan laid out in chapter three of this dissertation detailed that this aim would be tested in two parts. First, stratification techniques would be used in risk and odds ratio calculations to determine if weight status influenced higher pain outcomes when stratifying the sample by adults with high or low levels of each health factor. Second, it was planned that either pain intensity or pain interference would be entered in a multivariable regression model as a predictor along with other health factors, and BMI would be entered as the outcome.

When performing stratified analyses of risk and odds ratios, it became clear that a larger sample size would be needed to detect meaningful changes in health factors based on weight status and either pain intensity or pain interference. See Table 4.6 in chapter 4 for a reminder on the prevalence of health factors by weight status present in this sample. When stratifying the sample by those who had reported high levels of a given health factor and BMI category, very low numbers of cases were available for comparison in some cases. As such, a post-hoc power analysis was performed, showing that a minimum of 108 cases would have been required for each stratified health variable group to achieve 80% power. See Figure 5.1 below.

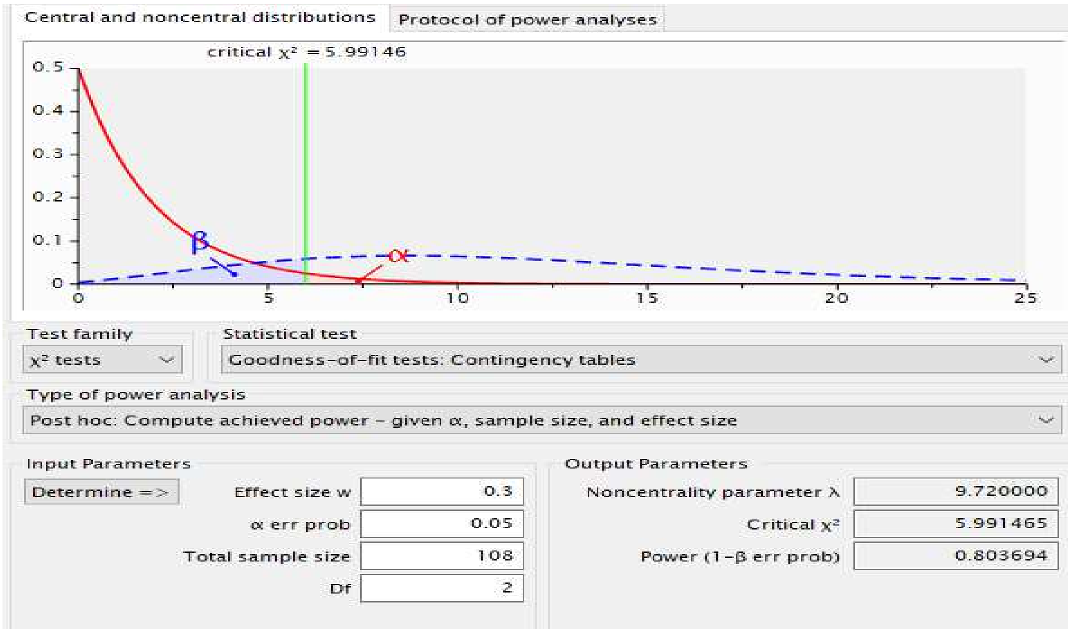

Figure 5.1 Power analysis for minimum sample size needed for risk and odds ratios

Furthermore, when separating the groups by high versus low pain interference or pain intensity caused instances of less than the minimum required 5 cases to detect the smallest possible effect size (Katz, 2011). With so few cases available to analyze when stratifying the sample, the need to test these relationships using risk and odds ratio stratification statistics with a larger sample size was clear. Thus, no evidence was provided through risk and odds ratios on the role of depression, sleep quality, or self-efficacy as effect modifiers on the relationship between weight status and pain outcomes from this sample. Future studies may benefit from utilizing larger sample sizes of adults with chronic pain using prescription opioid medications to more clearly delineate relationships.

A multivariable regression model was conducted to test for explanation of the variance in BMI as a continuous outcome in the context of all health variables of interest. In the model, higher levels of pain interference were able to predict increasing levels of BMI in multivariable regression analyses for this sample (data not shown). However, despite an overall significant model when including all health variables, pain interference remained the only variable able to independently predict high levels of BMI even when controlling for age and gender. Thus, to attain the primary study purpose, regression models were conducted using BMI as an independent variable as outlined in chapter three of this dissertation. Pain intensity served as the outcome in one model, and pain interference as the outcome in another. Results will be discussed in the following sections.

Multivariable Relationships with Pain Interference. Correlation statistics showed a significant and positive Pearson's correlation between pain interference and BMI among surveyed adults. In addition, pain interference was positively correlated with depression and poor sleep quality and negatively correlated with self-efficacy for symptom management. In regression analyses, depression, self-efficacy, and poor sleep quality all independently predicted variance in pain interference. When adding BMI, the model significantly increased explanatory power of pain interference, and BMI also independently predicted pain interference. All health symptoms remained significant when controlling for demographic variables of age and gender. In the final model, gender was not a significant predictor of pain interference, though older age did significantly predict higher levels of pain interference. Sleep quality was the strongest variable in explaining the variance in pain interference among all tested variables. These findings were supported in internal validation analyses until controlling for age and gender, at which point BMI was no longer an independent predictor of pain interference. In external validation analyses, BMI increased prediction of the variance of BMI among adults with CP and was independently able to explain pain interference until controlling for age and gender. Among adults with OUD, BMI increased prediction of the variance of pain interference but was not an independent predictor of pain interference until controlling for age and gender. Thus, in the overall sample, BMI strengthened relationships between health factors and pain interference which was partially supported through internal and external validation analyses.

Poor sleep quality emerged as the strongest predictor of pain interference in regression analyses. Prior studies support that pain and sleep quality are highly related (Adegbola, 2015; Cambell et al., 2013; Godfrey et al., 2018; Mundal et al., 2014; Morasco et al., 2015). Several studies suggest that sleep problems may worsen pain outcomes. For instance, in a large longitudinal population study, sleep problems at baseline were found to produce significantly higher odds for recurrence of chronic widespread pain 11 years later than prior anxiety, depression, or smoking status, though adults with baseline obesity compared to recommended weight had slightly higher odds for pain recurrence (Mundal et al., 2014). In a veteran study, adults with chronic pain who were prescribed opioids compared to those not prescribed opioids were more likely to have a sleep apnea diagnosis and report significantly worse sleep quality (Morasco et al., 2014). In a community study of adults with persistent pain, presence of sleep problems at baseline more than tripled the odds for having a diagnosis of depression three years later, and pain interference was found to significantly mediate this relationship (Campbell et al., 2013). Although the current science is not clear whether baseline sleep problems predispose to future reports of chronic pain or vice versa, it is evident that non-pharmacological interventions to support better sleep quality among adults with persistent pain who use opioid medications may be a pertinent starting point for treating both pain and weight outcomes. Targeting sleep may have the added benefit of improving mood and self-efficacy for adults in this population.

In overall analyses, BMI was found to significantly predict pain interference, even when controlling for age and gender. This finding appears to be in line with prior studies that support a relationship between pain and overweight status. For example, a large study of American adults found that as BMI increased, so did risk for chronic pain among both genders and all adult age groups (Stone & Broderick, 2012). In older adults, those with obesity compared to those without had higher pain disability scores and number of pain sites (Fowler-Brown et al., 2013). A meta-analysis also provided evidence that adults with overweight and obesity compared to recommended weight were more likely to have a diagnosis of chronic pain and to seek medical treatment for the pain (Shiri et al., 2009). In addition, weight loss appears to improve pain interference outcomes in several trials among adults with chronic pain (Foy et al., 2011; Somers et al., 2012; Vincent et al., 2014). Thus, a reduction in weight may help improve pain interference outcomes among adults with chronic pain who take prescription opioid medications regardless of age or gender.

In addition to BMI being an independent predictor of pain interference, it was also found to act as an effect modifier in the relationships between pain interference and the chosen health factors of depression, sleep quality, and self-efficacy. This is significant first because it was hypothesized that BMI would emerge as an effect modifier in the relationship between health factors and pain outcomes among adults with chronic pain. Second, this is a significant finding because it shows that in the context of overweight or obese status, an adult will have significantly worse pain interference outcomes, especially if also reporting poor sleep quality, low levels of self-efficacy for symptom management, and high levels of depressive symptoms. The finding that a higher BMI significantly worsens pain interference in the context of poor health factors among adults with chronic pain taking prescription opioid medications further supports a need for a holistic approach to pain management including treatment of weight status.

The current study was unable to validate findings completely through external and internal validation procedures. This may be due to being underpowered, barring ability to find a clinically relevant effect when reducing the sample size to conduct validation analyses as outlined in chapter three of this dissertation. Future studies should conduct internal and external validation analyses among these populations with significantly larger sample sizes to increase power and potentially uncover a clinically significant effect.

Multivariable Relationships with Pain Intensity. In bivariate analyses, no significant relationship emerged between pain intensity and weight status in this sample. Pain intensity was significantly and negatively correlated with self-efficacy and negatively with depression and poor sleep quality. In multivariable analyses, self-efficacy, depression, and poor sleep quality all independently predicted variance in pain intensity. However, self-efficacy was no longer able to significantly predict pain intensity when controlling for age, gender, and BMI, though sleep quality and depression remained significant in the model. Sleep quality held the highest weight in explaining relationships between all health variables and pain intensity in the model. In the final model, age was not a significant predictor of pain intensity, while female gender predicted higher levels of pain intensity. BMI had no impact on the relationships between health factors and pain intensity in either internal or external validation analyses. However, some differences were seen in the ability of health factors of sleep quality and self-efficacy to significantly and independently predict variance in pain intensity in internal and external validation analyses. Notwithstanding, BMI does not appear to act as an effect modifier in the relationships between health factors of depression, self-efficacy, and sleep quality and pain intensity.

As discussed above, many studies have been unable to cross-sectionally support a relationship between pain intensity and BMI among adults with any type of self-reported chronic pain condition (Fowler□Brown et al., 2013; Godfrey et al., 2018; Marcus, 2004; Pells et al., 2005). It may be that the measure of pain intensity is not as robust as pain interference when considering psychosocial impacts on both pain and overweight status, making pain intensity a less sensitive measure of pain than pain interference. In addition, among adults with joint-related pain such as osteoarthritis, pain intensity has been found to be related to weight status (Okifuji et al., 2010; Ryan et al., 2017; Vincent et al., 2014). As evidence supports a relationship between pain intensity and weight status among adults with joint-related chronic pain, analyzing the current data set with only those who reported a joint-related condition may have presented this finding. However, because assessing weight status in the context of joint-related pain was not the primary aim of the study, such an analysis was not performed. Future studies may benefit from validating whether certain types of chronic pain are more likely to increase risk for significantly higher pain intensity levels in the context of overweight status. Such knowledge may better support and guide patient-centered, individualized care.

Theoretical Considerations

The chosen theoretical framework for the present study was the Individual and Family Self-management Theory (IFSMT) as detailed in chapter two of this work. This theory was chosen based on its ability to address both chronic disease management and health promotion in a holistic manner for either an individual or a family unit. The theory emphasized the importance of patient-specific factors that can influence positive health outcomes such as family support or socioeconomic status. In the initial planning stages for the present study, the theoretical framework was used to make a conceptual model based on known relationships between all chosen health factors and hypothesized findings. Originally, a linear relationship was proposed between overweight status and symptoms relating to chronic pain in the target population. Based on the literature review guided by the theoretical framework, it was suspected that increasing levels of depression and poor sleep quality and decreasing levels of self-efficacy for symptom management would lead to increasing levels of pain intensity and pain interference, and that these relationships would be strengthened in the context of increasing levels of BMI. See figure 5.2 below for a visual of discovered relationships.

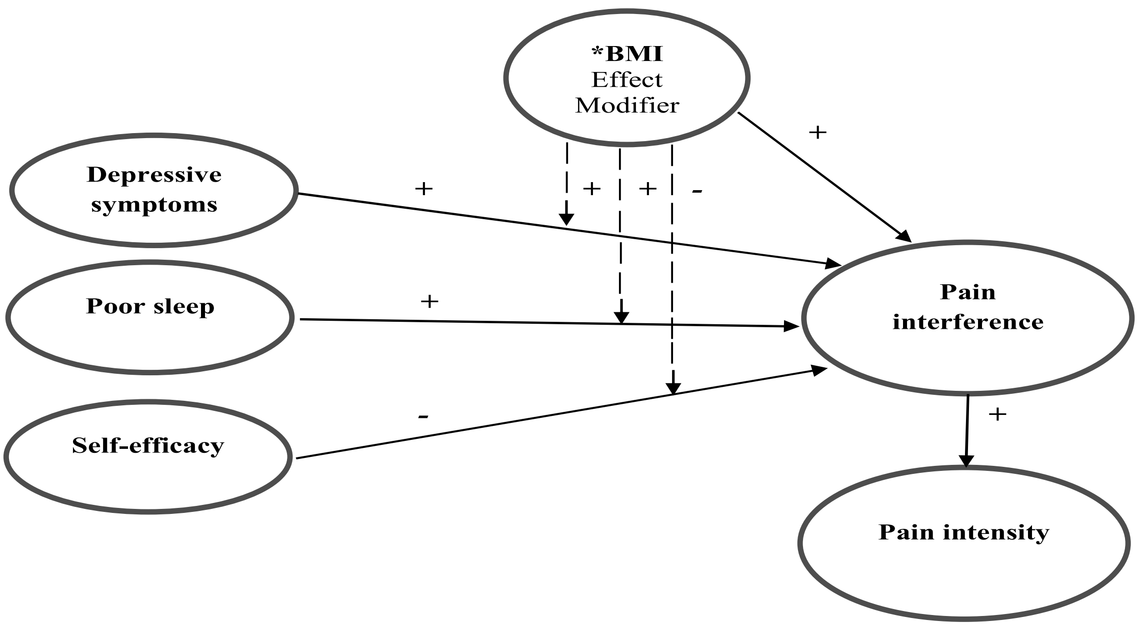

Figure 5.2 Relationships between health factors among adults with chronic pain and prescription opioid use

A complex relationship was found between chosen health factors and pain outcomes. As current literature suggests, the present study found that increasing levels of depression (Masheb et al., 2015; Tietjen et al., 2007) and poor sleep quality (Shade et al., 2016) and decreasing levels of self-efficacy for symptom management (Pells et al., 2008) were related to higher levels of both pain intensity and pain interference among adults with chronic pain. Furthermore, increasing levels of BMI significantly strengthened relationships between all health factors and pain interference and independently explained worsening levels of pain interference. However, BMI did not significantly strengthen relationships between health factors and pain intensity or independently predict changes in pain intensity levels, though sleep quality and depression both independently explained pain intensity.

Healthcare providers today are understanding the importance of designing treatments that improve patient-reported functional outcomes as opposed to eliminating the pain severity or intensity experience. Reduction in pain interference versus pain intensity has been proposed among adults with chronic pain who are recovering from substance use disorders (Center for Substance Abuse Treatment, 2012) and for those who do not have a diagnosed substance use disorder (Dworkin et al., 2005). Targeting pain interference may be more beneficial to improve emotional well-being and other aspects of daily function that will in turn improve pain outcomes (Somers et al., 2012) as opposed to relieving subjective reports of pain intensity. Thus, it is important to note that while BMI may not be related to pain intensity in this population, BMI is related to pain interference. Treatment of overweight status in the context of chronic pain can be guided through the IFSMT framework and should be included in a holistic plan of care to best improve outcomes like pain interference among adults taking prescription opioid medications.

According to the IFSMT, disease management and health promotion should occur simultaneously (Ryan & Sawin, 2009). Mismanaged disease states may often lead to further illness and can worsen health outcomes. For instance, untreated hypertension, a common risk factor in the context of overweight status (Afshin et al., 2017), may lead to a stroke which can leave an individual with permanent physical disability (Banasik & Copstead, 2018) and is even more difficult to manage in the context of co-occurring chronic pain (Olawale, Ajepe, Oke, & Ezeugwa, 2017). Thus, having a multi-disciplinary approach to the care of the adult with chronic pain and overweight status is imperative. Management of co-morbid chronic illnesses is complex, extending beyond an individual's physical symptoms and encompassing psychosocial, environmental, developmental, spiritual, and cultural domains. All healthcare providers should work together to empower patients to play an active role in self-management of symptoms in the long-term for best results. Having an integrative, team-based approach to care may help mitigate the feeling of fragmentation of care reported by some patients with chronic pain and co-occurring overweight status (Janke et al., 2016). Standardized data tracking should be in place to monitor improved patient outcomes and cost-savings when using a multi-modal, interdisciplinary approach to pain and weight management to provide an evidence base for continued funding and insurance reimbursement of such efforts.

Implications for Education and Clinical Practice

Arguably, the most important aspect of any study relates to how findings can be applied in a real-world setting. Scientific studies are required to have a meaningful impact on the world, otherwise there is no indication for spending time and resources on the research (Polit & Beck, 2016). Several implications for both education and clinical practice can be derived from current study findings. Implications for health care provider education will be discussed first, then applications for clinical practice will be presented.

Implications for Education. Healthcare providers should receive detailed, routine education about the importance of holistic treatment of complex populations such as adults with chronic pain taking opioid medications. Knowledge of complementary and holistic treatment of chronic pain is timely, given that national guidelines have been published in response to the increase in opioid-related deaths urging practitioners to avoid initiation of opioid medications for management of chronic pain and to follow a strict protocol for prescription and dose escalation of such drugs (Dowell, Haegerich, & Chou, 2016). Opioid medications have been found to produce sub-optimal pain relief for adults with chronic pain (Krebs et al., 2018; Morasco et al., 2014; Seal et al., 2012), particularly in the context of co-occurring overweight status (Thomazeau et al., 2014). Furthermore, among adults with sleep apnea, a condition highly correlated with overweight status (Schumacher, 2012), long-term opioid use has been associated with increased risk for respiratory distress and lack of oxygen to the brain (Filiatrault et al., 2016) Thus, knowledge regarding therapies alternative to long-term opioid use to manage chronic pain, especially in the context of overweight status, are needed for current healthcare providers and students.

Evidence suggests that on average, complementary therapies may be more effective than traditional pain medications at managing symptoms for adults with chronic pain. For instance, acupuncture was found in a recent meta-analysis to be more effective at reducing pain than placebo acupuncture or an analgesia injection (Xiang et al., 2017). Healthcare prelicensure programs should incorporate evidence showing how lifestyle interventions and emotional support can improve pain outcomes. As an example, a meta-analysis demonstrated moderate evidence that yoga as a treatment modality helped improve mood and reduce pain intensity and pain interference among adults with a wide variety of chronic pain conditions (Büssing, Ostermann, Lüdtke, & Michalsen, 2012). Licensure exams should include content on integrative treatment options for adults with co-occurring chronic pain and obesity. Requiring formal, evidence-based exposure to complementary and non-opioid alternatives for pain management in prelicensure programs will facilitate preparation of healthcare providers who are comfortable informing patients of best practice options to manage pain in the context of co-morbid health issues and prescribing such therapies. In addition, teaching students and current healthcare providers to assess each patient individually for response to both pharmacological and non-pharmacological treatment is vital to implementation of a successful pain management care plan.

Implications for Clinical Practice. In this sample, adults reported taking current prescription opioid medication for an average of 6 years, yet self-reported symptom burden was high. Thus, supplementary and alternative pain management techniques may be required to obtain desired positive health outcomes. An interdisciplinary team could be used to treat pain given that adults with chronic pain suffer a variety of burdensome symptoms that are difficult to self-manage especially in the context of overweight status (Janke et al., 2016). Sleep emerged as the strongest predictor of both pain interference and pain intensity in this study and could provide a favorable symptom to target first as an integrative treatment option in this population. Sleep specialists could be utilized to screen for and treat sleep disorders. Providers can then work together to treat sleep disorders and target pain interference using evidence-based therapies.

Data suggest that an integrative approach utilizing diverse health professionals is beneficial for management of multiple symptoms among adults with chronic pain. For instance, evidence supports that use of mental health specialists to create cognitive behavioral therapies can improve sleep (Ho et al., 2015; Kwekkeboom et al., 2018), pain (Turner et al., 2016), mood and weight loss (Somers et al., 2012), and self-efficacy (Williams, Eccleston, & Morley, 2012) among adults with chronic pain. Psychologists could thus be consulted to treat depressive symptoms which may positively impact related pain and health symptoms in this population. In addition, physical therapists can create tailored, safe exercise routines for patients with chronic pain which may improve pain and weight outcomes (Vincent et al., 2014). Nutritionists could create healthy meal plans to promote weight management aimed at pain reduction which has been implemented for adults with chronic migraines with success (Ramsden et al., 2015).

Clearly, a multi-disciplinary approach can yield comprehensive health outcomes for adults with chronic pain and overweight status who use prescription opioid medications and report a complex bundle of adverse symptoms. Steps should be taken to integrate multimodal approaches targeting specific symptoms for adults with chronic pain within the clinical practice setting. A system should be put in place for monitoring the impact of implementation of alternative and adjunctive pain management strategies on patient health status, symptom burden, and changes in prescription opioid use over time.

Strengths and Limitations

The present study had several limitations that are pertinent to discuss. First, the study design is inherently weak as a secondary analysis. Conducting a secondary analysis limits the researcher in that the data has already been gathered, so no changes to study methodology can be implemented. Notwithstanding, the researcher performing the secondary analysis was involved with the parent study from the planning phase through data analyses, and thus was able to contribute to study design and proposal of pertinent materials. A second limitation was that the parent study was cross-sectional. Cross-sectional work cannot provide information about causal relationships as factors are not tested over time. However, the aim of the current study was to explore relationships and not to understand causation, making the study design appropriate.

Another limitation was that the parent study used convenience sampling, which is potentially not as informative as a random sampling technique (Polit & Beck, 2016). However, given that the sample closely matched demographics of the surveyed region, this did not appear to influence study findings. Finally, the parent study used only self-report data to measure factors, leaving room for error if a participant accidentally or purposefully skipped questions on the survey or provided dishonest answers. The use of self-report data as opposed to more invasive measures has several potential advantages such as superior cost-efficiency, decreased time burden on participants, improved compliance with study procedures, and less risk of participant harm (Polit & Beck, 2016). Additionally, self-report measures are considered gold standard when assessing subjective health outcomes such as pain or emotional well-being (Dworkin et al., 2005). Furthermore, the selection of tools with high validity and reliability in the target population as outlined in chapter three of this dissertation increases confidence in the scientific accuracy of findings.

The current study also presented with several strengths. The first strength was the selection of participants from five separate clinics. Multi-site sampling decreases risk for independence of observations and enhances study rigor (Portney & Watkins, 2013). In addition, inclusion of adults with any chronic pain condition was a strength. Many studies that explore the relationships between chronic pain and weight status focus on adults with joint-related pain (Badley, Canizares, & Perruccio, 2017; Heuch et al., 2013; Messier et al., 2014; Okifuji et al., 2010; Thomazeau et al., 2014; Vincent et al., 2014). Inclusion of all adults with any self-reported pain condition allowed researchers to test whether relationships between pain outcomes and BMI persist among adults with chronic pain including non-joint-related pain.

The inclusion criteria of prescription opioid use among adults with CP contributed to the strengths of this study. The existing literature indicates poor efficacy of opioid medications in managing pain and weight outcomes among adults with CP. For example, a retrospective chart review of veterans with chronic pain found significantly higher levels of pain interference and pain intensity levels among those taking prescribed opioid medications compared to those without a prescription opioid (Morasco et al., 2010). Furthermore, in the period awaiting joint replacement, adults with overweight status required higher opioid doses and yet had significantly greater pain interference levels than normal weight adults (Thomazeau et al., 2014). Additionally, in a recent randomized-controlled trial among adults with chronic pain disorders, those receiving opioids compared to acetaminophen or ibuprofen had significantly worse pain intensity and pain interference scores (Krebs et al., 2018). Finally, among Veterans with chronic pain, opioid prescriptions were found to be correlated with having a mental health diagnosis; a diagnosis of PTSD was related to higher doses of prescription opioid medications, seeking early refills on drugs, co-prescription of other sedative drugs, and longer duration of opioid therapy (Seal et al., 2012). Given the potential negative impact of opioid medications on pain and health outcomes, it was important to conduct research to identify how best to manage pain within an opioid-dependent population, especially in the context of co-occurring overweight or obesity.

Another strength of the study was that it was novel to require current prescription opioid use as an inclusion criterion. This inclusion criteria allowed for sampling of adults with self-reported chronic pain receiving active treatment for OUD or CP was a unique recruitment approach. Chronic pain is widely prevalent among adults diagnosed with OUD (Hser et al., 2017), yet literature on relationships between modifiable health factors and pain is limited in this population. Current policies are focused on reducing overall opioid prescription in light of what has been termed “the opioid crisis” (Kolodny et al., 2015). Identification of the current state of relationships among health factors and pain in this population is a first step in understanding how to treat underlying symptoms with targeted treatments. In contrast, prescription of an opioid medication acts to non-specifically blunt pain signals and fails to address pertinent health factors such as emotional well-being, sleep quality, or overweight status.

Future Research Directions

As discussed throughout this chapter, the current study provides evidence for several continued research avenues. First, future research should focus on validating observed relationships among adults with chronic pain taking prescription opioid medications in other geographic locations on a larger scale to ensure adequate statistical power for findings. Validating whether results are generalizable to similar populations in other geographic, more ethnically diverse areas is crucial before acting to identify and test viable interventions. An increased sample size is also needed to best understand the risk and odds ratios for increased pain intensity and pain interference among adults with overweight status compared to recommended weight status in the context of self-efficacy, sleep quality, and depressive symptoms. Additionally, other measures of weight status known to be correlated to health outcomes such as waist-hip ratio should be tested to understand whether BMI remains an accurate measure of the relationship between overweight and chronic pain.

The role of overweight status on pain intensity outcomes requires more investigation. Future prevalence studies should be conducted to determine whether certain types of chronic pain such as joint-related pain may increase levels of pain intensity in the context of overweight status compared to recommended weight status. In addition, further scientific evidence is needed showing that a multi-modal approach to management of pain and overweight status may improve health outcomes, especially when focusing in improving self-efficacy for symptom management, sleep quality, and depressive symptoms. Finally, longitudinal studies should be designed to help illustrate how these health factors evolve over time and impact weight status and pain outcomes. Once clear evidence emerges regarding simultaneous pain and weight management among adults with both conditions who use prescription opioids, treatment options can be tested in randomized-controlled trials to reduce opioid usage and improve both pain and weight outcomes.

Conclusions

Weight status and pain interference are related among adults with chronic pain using prescription opioid medications. In this sample, higher levels of depression, higher levels of poor sleep quality, and lower levels of self-efficacy for symptom management explained higher levels of pain interference and pain intensity in a cross-sectional analysis. The relationships between health factors and pain interference but not pain intensity were significantly stronger in the context of an elevated BMI, even when controlling for age and gender. Sleep quality was the strongest explanatory variable in pain interference and pain intensity models, suggesting that sleep is a pertinent health symptom to screen for and treat. Although the same results were not able to be internally or externally validated for the outcome of pain interference, preliminary data suggest that providers need to treat both pain and overweight status, otherwise multiple health symptoms may be worse. The current study supports that relationships between health factors of depression, sleep quality, self-efficacy for symptom management, BMI, pain intensity, and pain interference are complex and do not follow a linear path. Future studies should validate findings on a larger scale and perform longitudinal analyses to follow changes in relationships between health factors over time. Intervention studies may then be designed to test appropriate strategies for treating both overweight status and any type of chronic pain condition with the goal to reduce reliance on opioid medications. Healthcare providers should receive education about the need to treat chronic pain using an integrative, team-based approach to mitigate the negative health impacts of co-occurring overweight status and chronic pain.

REFERENCES

Adegbola, M. (2015). Sleep quality, pain and self-efficacy among community-dwelling adults with sickle cell disease. *Journal of National Black Nurses' Association, 26*(1), 15-21.

Afshin, A., Forouzanfar, M., Reitsma, M., Sur, P., Estep, K., … Rnlov, J. (2017). Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *The New England Journal of Medicine, 377*(1), 13-27. doi:10.1056/NEJMoa1614362

Allen, S., Da Grande, E., Abernathy, A., & Currow, D. (2016). Two colliding epidemics - obesity is independently associated with chronic pain interfering with activities of daily living in adults 18 years and over; a cross-sectional, population-based study. *Biomed Central Medicine Public Health, 16*(1). https://doi.org/10.1186/s12889-016-3696-3

Alsaadi, S., McAuley, J., Hush, J., Bartlett, D., Henschke, N., Grunstein, R.., & Maher, C. (2013). Detecting insomnia in patients with low back pain: Accuracy of four self-report sleep measures. *BMC Musculoskeletal Disorders, 14*, 196. https://doi.org/10.1186/1471 2474-14-196

Amtmann, D. F., Cook, K. P., Jensen, M., Chen, W., Choi, S., Revicki, D., . . . Lai, J. (2010). Development of a PROMIS item bank to measure pain interference. *Pain, 150*(1), 173 182. https://doi.org/10.1016/j.pain.2010.04.025

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders, (5th ed.).* Arlington, VA, American Psychiatric Association.

Ara, A., Jacobs, W., Bhat, I. A., & McCall, W. V. (2016). Sleep disturbances and substance use disorders: a bi-directional relationship. *Psychiatric Annals*, *46*(7), 408-412. https://doi.org/10.3928/00485713-20160512-01

Badley, E. M., Canizares, M., & Perruccio, A. V. (2017). Population□based study of changes in arthritis prevalence and arthritis risk factors over time: generational differences and the role of obesity. *Arthritis Care & Research*, *69*(12), 1818-1825. doi:10.1002/acr.23213

Banasik, J. L., Copstead, L. C. (2018) Pathophysiology (6th ed.). St. Louis, Missouri: Elsevier.

Beck, S., Schwartz, A., Towsley, G., Dudley, W., & Barsevick, A. (2004). Psychometric evaluation of the Pittsburgh sleep quality index in cancer patients. *Journal of Pain and Symptom Management,* 27(2), 140-148. https://doi.org/10.1016/j.jpainsymman.2003.12.002

Bigand, T., Daratha, K., Wilson, M., Bindler, R. (2018). Examining risk for persistent pain among adults with overweight status. *Pain Management Nursing*, *19*(2), 549-556. https://doi.org/10.1016/j.pmn.2018.02.066

Bonakdar, R. (2013). Targeting systemic inflammation in patients with obesity-related pain: Time for a new approach that targets systemic inflammation. *The Journal of Family Practice, 62*(9), S22-29.

Boody, B., Bhatt, S., Mazmudar, A., Hsu, W., Rothrock, N., & Patel, A. (2018). Validation of Patient-Reported Outcomes Measurement Information System (PROMIS) computerized adaptive tests in cervical spine surgery. *Journal of Neurosurgery & Spine, 28*(3), 268 279.

Breivik, H., Collett, B., Ventafridda, V., Cohen, R., & Gallacher, D. (2006). Survey of chronic pain in Europe: prevalence, impact on daily life, and treatment. *European journal of pain*, *10*(4), 287-333. https://doi.org/10.1016/j.ejpain.2005.06.009

Broderick, J., Schneider, S., Junghaenel, D., Schwartz, J., & Stone, A. (2013). Validity and reliability of patient-reported outcomes measurement information system instruments in osteoarthritis. *Arthritis Care & Research, 65*(10), 1625-33. https://doi.org/10.1002/acr.22025

Burkhalter, H., Sereika, S., Engberg, S., Wirz□Justice, A., Steiger, J., & De Geest, S. (2010). Structure validity of the Pittsburgh Sleep Quality Index in renal transplant recipients: A confirmatory factor analysis. *Sleep and Biological Rhythms,* 8(4), 274-281 doi:10.1111/j.1479-8425.2010.00473.x

Büssing, A., Ostermann, T., Lüdtke, R., & Michalsen, A. (2012). Effects of yoga interventions on pain and pain-associated disability: a meta-analysis. *The Journal of Pain*, *13*(1), 1-9. https://doi.org/10.1016/j.jpain.2011.10.001

Buyesse, D., Reynolds, C., Monk, T., Berman, S., & Kupfer, D. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193-213. https://doi.org/10.1016/0165-1781(89)90047-4

Çakır, T., Oruç, M. T., Aslaner, A., Duygun, F., Yardımcı, E. C., Mayir, B., & Bülbüller, N. (2015). The effects of laparoscopic sleeve gastrectomy on head, neck, shoulder, low back and knee pain of female patients. *International Journal of Clinical and Experimental Medicine*, 8(2), 2668.

Campbell, P., Tang, N., Mcbeth, J., Lewis, M., Main, C., Croft, P., . . . Dunn, K. (2013). The role of sleep problems in the development of depression in those with persistent pain: A prospective cohort study. *Sleep, 36*(11), 1693-8. https://doi.org/10.5665/sleep.3130

Campbell, C. I., Weisner, C., LeResche, L., Ray, G. T., Saunders, K., Sullivan, M. D., ... & Satre, D. D. (2010). Age and gender trends in long-term opioid analgesic use for noncancer pain. *American Journal of Public Health*, *100*(12), 2541-2547. doi:10.2105/AJPH.2009.180646

Cappuccio, F., Taggart, F., Kandala, N., Currie, A., Peile, E., Stranges, S., & Miller, M. (2008). Meta-analysis of short sleep duration and obesity in children and adults. *Sleep, 31*(5), 619-26. https://doi.org/10.1093/sleep/31.5.619

Cassidy, S., Trenell, M., & Anderson, K. (2017). The cardio-metabolic impact of taking commonly prescribed analgesic drugs in 133,401 UK Biobank participants. *PLoS One, 12*(12), E0187982. https://doi.org/10.1371/journal.pone.0187982

Center for Substance Abuse Treatment. (2012). Managing chronic pain in adults with or in recovery from substance use disorders. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK92054/

Centers for Disease Control. (2017). Adult Obesity Prevalence in Canada and the United States. Retrieved from https://www.cdc.gov/nchs/products/databriefs/db56.htm

Chen, W., Revicki, D., Amtmann, D., Jensen, M., Keefe, F., & Cella, D. (2012). Development and Analysis of PROMIS Pain Intensity Scale. *Quality of Life Research, 20*, 18.

Choi, Y., Mayer, T., Williams, M., & Gatchel, R. (2014). What is the best screening test for depression in chronic spinal pain patients? *The Spine Journal, 14*(7), 1175-1182. https://doi.org/10.1016/j.spinee.2013.10.037

Chou, L., Brady, S. R. E., Urquhart, D. M., Teichtahl, A. J., Cicuttini, F. M., Pasco, J. A., . . . Wluka, A. E. (2016). The association between obesity and low back pain and disability is affected by mood disorders: A population-based, cross-sectional study of men. *Medicine, 95*(15). doi:10.1097/MD.0000000000003367

Cook, K., Schalet, B., Kallen, M., Rutsohn, J., & Cella, D. (2015). Establishing a common metric for self-reported pain: Linking BPI Pain Interference and SF-36 Bodily Pain Subscale scores to the PROMIS Pain Interference metric. *Quality of Life Research: An International Journal of Quality of Life Aspects of Treatment, Care and Rehabilitation, 24*(10), 2305-18. https://doi.org/10.1007/s11136-015-0987-6

Cummings, P. (2009). The relative merits of risk ratios and odds ratios. *Archives of Pediatrics & Adolescent Medicine*, *163*(5), 438-445. doi:10.1001/archpediatrics.2009.31

Dahlhamer J., Lucas J., Zelaya, C., Nahin, R., Mackey, S., DeBar, L., . . . & Helmick, C. (2018). Prevalence of chronic pain and high-impact chronic pain among adults — United States, 2016. *Morbidity and Mortal Weekly Report, 67*(36), 1001–1006. http://dx.doi.org/10.15585/mmwr.mm6736a2.

Dario, A. B., Ferreira, M. L., Refshauge, K. M., Lima, T. S., Ordoñana, J. R., & Ferreira, P. H. (2015). The relationship between obesity, low back pain, and lumbar disc degeneration when genetics and the environment are considered: a systematic review of twin studies. *The Spine Journal*, *15*(5), 1106-1117. http://dx.doi.org/10.1016/j.spinee.2015.02.001 1529-9430/

De Rooij, A., Dekker, J., De Boer, M., Van Der Leeden, L., Roorda, A., & Steultjens, J. (2014). Cognitive mechanisms of change in multidisciplinary treatment of patients with chronic wide spread pain. *International Journal of Behavioral Medicine, 21*(S1), S134-S135. https://doi.org/10.2340/16501977-1252

de Wit, L., Luppino, F., van Straten, A., Penninx, B., Zitman, F., & Cuijpers, P. (2010). Depression and obesity: A meta-analysis of community-based studies. *Psychiatry Research, 178*(2), 230-235. doi:10.1016/j.psychres.2009.04.015

Doering, J. (2013). The Physical and Social Environment of Sleep in Socioeconomically Disadvantaged Postpartum Women. *Journal Of Obstetric Gynecologic And Neonatal Nursing, 42*(1), E33-E43. doi:10.1111/j.1552-6909.2012.01421.x

Dowell, D., Haegerich, T. M., & Chou, R. (2016). CDC guideline for prescribing opioids for chronic pain—United States, 2016. *JAMA*, *315*(15), 1624-1645. doi:10.1001/jama.2016.1464

Drug Enforcement Administration. (2018). 2018 National drug threat assessment. Retrieved from https://www.dea.gov/sites/default/files/2018-11/DIR-032 18%202018%20NDTA%20final%20low%20resolution.pdf

Dworkin, R. H., Turk, D. C., Farrar, J. T., Haythornthwaite, J. A., Jensen, M. P., Katz, N. P., ... & Carr, D. B. (2005). Core outcome measures for chronic pain clinical trials: IMMPACT recommendations. *Pain*, *113*(1), 9-19. doi: 10.1016/j.pain.2004.09.012

Ewald, S., Hurwitz, E., & Kizhakkeveettil, A. (2016). The effect of obesity on treatment outcomes for low back pain. *Chiropractic & Manual Therapies, 24*(1). doi: 10.1186/s12998-016-0129-4

Fenn, J. M., Laurent, J. S., & Sigmon, S. C. (2015). Increases in body mass index following initiation of methadone treatment. *Journal of Substance Abuse Treatment*, *51*, 59-63. https://doi.org/10.1016/j.jsat.2014.10.007

Filiatrault, M.L., Chauny, J.M., Daoust, R., Roy, M.P., Denis, R., & Lavigne, G. (2016). Medium increased risk for central sleep apnea but not obstructive sleep apnea in long term opioid users: A systematic review and meta-analysis. *Journal of Clinical Sleep Medicine: American Academy of Sleep Medicine*, *12*(4), 617–625. http://doi.org/10.5664/jcsm.5704

Fillingim, R. (2017). Sex, Gender, and Pain. In Legato, M. (3rd ed.), *Principles of Gender Specific Medicine: Gender in the Genomic Era* (481-486). San Diego: Academic Press.

Finkelstein, E. A., Trogdon, J. G., Cohen, J. W., & Dietz, W. (2009). Annual medical spending attributable to obesity: payer-and service-specific estimates. *Health affairs*, *28*(5), w822-w831. https://doi.org/10.1377/hlthaff.28.5.w822

Fowler□Brown, A., Wee, C., Marcantonio, E., Ngo, L., & Leveille, S. (2013). The mediating effect of chronic pain on the relationship between obesity and physical function and disability in older adults. *Journal of the American Geriatrics Society, 61*(12), 2079-2086. doi:10.1111/jgs.12512

Foy, C., Lewis, C., Hairston, K., Miller, G., Lang, W., Jakicic, J…& Wagenknecht, L. (2011). Intensive lifestyle intervention improves physical function among obese adults with knee pain: Findings from the look AHEAD trial. *Obesity, 19*(1), 83-93. doi:10.1038/oby.2010.120.

Franz, M., Vanwormer, J., Crain, L., Boucher, J., Histon, T., Caplan, W., Bowman, J., & Pronk, N. (2008). Weight-loss outcomes: A systematic review and meta-analysis of weight loss clinical trials with a minimum 1-year follow-up. *Journal of the American Dietetic Association, 107,* 1755-1767. doi:10.1016/j.jada.2007.07.017

Freburger, J., Holmes, G., Agans, R., Jackman, A., Darter, J., Wallace, A., . . . Carey, T. (2009). The rising prevalence of chronic low back pain. *Archives of Internal Medicine, 169*(3), 251-258. doi:10.1001/archinternmed.2008.543

Fullerton, C. A., Kim, M., Thomas, C. P., Lyman, D. R., Montejano, L. B., Dougherty, R. H., ... & Delphin-Rittmon, M. E. (2014). Medication-assisted treatment with methadone:

assessing the evidence. *Psychiatric services*, *65*(2), 146-157. https://doi.org/10.1176/appi.ps.201300235

Godfrey, K. M., Bullock, A., Dorflinger, L., Min, K. M., Ruser, C., & Masheb, R. M. (2018). Pain and modifiable risk factors among weight loss seeking Veterans with overweight. *Appetite, 128*(1), 100-105. https://doi.org/10.1016/j.appet.2018.06.010

Gruber-Baldini, A., Velozo, L., Romero, C., & Shulman, S. (2017). Validation of the PROMIS ® measures of self-efficacy for managing chronic conditions. *Quality of Life Research, 26*(7), 1915-1924. https://doi.org/10.1007/s11136-017-1527-3

Haefeli, M., & Elfering, A. (2006). Pain assessment. *European Spine Journal*, *15*(Suppl 1), S17 S24. http://doi.org/10.1007/s00586-005-1044-x

Hales, C., Carroll, M., Fryar, C., & Ogden, C. (2017). Prevalence of obesity among adults and youth: United States, 2015-2016. *NCHS Data Brief,* (288), 1-8.

Hardt, J., Jacobsen, C., Goldberg, J., Nickel, R., & Buchwald, D. (2008). Prevalence of chronic pain in a representative sample in the United States. *Pain Medicine*, *9*(7), 803-812. https://doi.org/10.1111/j.1526-4637.2008.00425.x

Healthcare.gov. (2018). Federal poverty level. Retrieved from https://www.healthcare.gov/glossary/federal-poverty-level-fpl/

Heuch, I., Heuch, I., Hagen, K., & Zwart, J. (2015). A comparison of anthropometric measures for assessing the association between body size and risk of chronic low back pain: The HUNT study. *PLOS One, 10*(10). https://doi.org/10.1371/journal.pone.0141268

Heuch, I., Heuch, I., Hagen, K., & Zwart, J. (2013). Body mass index as a risk factor for developing chronic low back pain: A follow-up in the Nord-Trøndelag Health Study. *Spine, 38*(2), 133. doi:10.1097/BRS.0b013e3182647af2

Ho, F. Y. Y., Chung, K. F., Yeung, W. F., Ng, T. H., Kwan, K. S., Yung, K. P., & Cheng, S. K. (2015). Self-help cognitive-behavioral therapy for insomnia: a meta-analysis of randomized controlled trials. *Sleep Medicine Reviews*, *19*, 17-28. http://dx.doi.org/10.1016/j.smrv.2014.06.010

Holcomb, Z. (2016). *SPSS basics: Techniques for a first course in statistics* (5th ed.). Glendale, CA: Pyrczak Pub.

Hozumi, J., Sumitani, M., Matsubayashi, Y., Abe, H., Oshima, Y., Chikuda, H., . . . Yamada, Y. (2016). Relationship between neuropathic pain and obesity. *Pain Research and Management, 2016*(6). http://dx.doi.org/10.1155/2016/2487924

Hser, Y., Mooney, L., Saxon, A., Miotto, K., Bell, D., & Huang, D. (2017). Chronic pain among patients with opioid use disorder: Results from electronic health records data. *Journal of Substance Abuse Treatment, 77*, 26-30. doi: 10.1016/j.jsat.2017.03.006.

IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.

Janke, E., & Kozak, A. T. (2012). The more pain I have, the more I want to eat: obesity in the context of chronic pain. *Obesity, 20*(10), 2027-2034. doi:10.1038/oby.2012.39

Janke E., Ramirez M., Haltzman B., Fritz M., & Kozak A. (2016). Patient's experience with comorbidity management in primary care: a qualitative study of comorbid pain and obesity. *Primary Health Care Resource Development.17*(1):33-41. doi: 10.1017/S1463423615000171

Johannes, C. B., Le, T. K., Zhou, X., Johnston, J. A., & Dworkin, R. H. (2010). The prevalence of chronic pain in United States adults: results of an Internet-based survey. *The Journal of Pain*, *11*(11), 1230-1239. https://doi.org/10.1016/j.jpain.2010.07.002

Kaasboll, J., Ranoyen, I., Nilsen, W., Lydersen, S., & Indredavik, M. (2015). Associations between parental chronic pain and self-esteem, social competence, and family cohesion in adolescent girls and boys - family linkage data from the HUNT study. *BMC Public Health, 15*(1), 817. https://doi.org/10.1186/s12889-015-2164-9

Katz, M. (2011). *Multivariable analysis: A practical guide for clinicians and public health researchers* (3rd ed.). Cambridge, New York: Cambridge University Press.

Kelly, J. P., Cook, S. F., Kaufman, D. W., Anderson, T., Rosenberg, L., & Mitchell, A. A. (2008). Prevalence and characteristics of opioid use in the US adult population. *Pain*, *138*(3), 507-513. https://doi.org/10.1016/j.pain.2008.01.027

Khalesi, S., Irwin, C., & Sun, J. (2017). Dietary patterns, nutrition knowledge, lifestyle, and health-related quality of life: Associations with anti-hypertension medication adherence in a sample of Australian adults. *High Blood Pressure & Cardiovascular Prevention*, *24*(4), 453-462. https://doi.org/10.1007/s40292-017-0229-9

Khoueir P., Black M., Crookes P., Kaufman H., Katkhouda N., & Wang M. (2009). Prospective assessment of axial back pain symptoms before and after bariatric weight reduction surgery. *Spine, 9*(6):454–463. doi: 10.1016/j.spinee.2009.02.003.

Koch, A., Zacharowski, K., Boehm, O., Stevens, M., Lipfert, P., Von Giesen, H., ... & Freynhagen, R. (2007). Nitric oxide and pro-inflammatory cytokines correlate with pain intensity in chronic pain patients. *Inflammation Research*, *56*(1), 32-37. doi:10.1007/s00011-007-6088-4

Kolodny, A., Courtwright, D., Hwang, C., Kreiner, P., Eadie, J., Clark, T., & Alexander, G. (2015). The prescription opioid and heroin crisis: A public health approach to an epidemic of addiction. *Annual Review of Public Health, 36*, 559-574. doi: 10.1146/annurev-publhealth-031914-122957

Koyanagi, A., Stickley, A., Garin, N., Miret, M., Ayuso-Mateos, J., Leonardi, M., . . . Haro, J. (2015). The association between obesity and back pain in nine countries: A cross sectional study. *BMC Public Health, 15* (1), 123. https://doi.org/10.1186/s128890151362-9

Knerr, S., Bowen, D., Beresford, S., & Wang, C. (2015). Genetic causal beliefs about obesity, self-efficacy for weight control, and obesity-related behaviours in a middle-aged female cohort. *Psychology & Health,* 1-28. https://doi.org/10.1080/08870446.2015.1115503

Krebs, E., Gravely, A., Nugent, S., Jensen, A., Deronne, B., Goldsmith, E., . . . Noorbaloochi, S. (2018). Effect of opioid vs nonopioid medications on pain-related function in patients with chronic back pain or hip or knee osteoarthritis pain: The SPACE randomized clinical trial. *JAMA, 319*(9), 872-882. doi:10.1001/jama.2018.0899

Kroenke, K., Spitzer, R. L., Williams, J. B. W., & Löwe, B. (2010). The Patient Health Questionnaire somatic, anxiety, and depressive symptom scales: A systematic review. *General Hospital Psychiatry*, *32*(4), 345–359. https://doi.org/10.1016/j.genhosppsych.2010.03.006

Kumar, D., Beavers, D., Devita, P., & Messier, S. (2017). Effects of weight-loss on patellofemoral loading in overweight and obese adults with patellofemoral osteoarthritis: Secondary analysis from the idea randomized trial. *Osteoarthritis and Cartilage, 25*, S171-S172. doi: http://dx.doi.org/10.1016/j.joca.2017.02.296

Kwekkeboom, K., Zhang, Y., Campbell, T., Coe, C. L., Costanzo, E., Serlin, R. C., & Ward, S. (2018). Randomized controlled trial of a brief cognitive□behavioral strategies intervention for the pain, fatigue, and sleep disturbance symptom cluster in advanced cancer. *Psycho Oncology (Epub ahead of print*). https://doi.org/10.1002/pon.4883

Lake, J., Power, C., & Cole, T. (2000). Back pain and obesity in the 1958 British birth cohort. cause or effect? *Journal of Clinical Epidemiology, 53*(3), 245-250.

Lier, R., Mork, P. Holtermann, A., & Nilsen, T. (2016). Familial risk of chronic musculoskeletal pain and the importance of physical activity and body mass index: Prospective data from the HUNT study, Norway. *PloS one., 11*(4). https://doi.org/10.1371/journal.pone.0153828

Luis Román, D., Izaola Jáuregui, O., García Alonso, M., Aller de la Fuente, R., Cabezas, G., & De la Fuente, B. (2012). Effect of a hypocaloric diet with a commercial formula in weight loss and quality of life in obese patients with chronic osteoarthritis. *Nutrición Hospitalaria: Organo Oficial de la Sociedad Española de Nutrición Parenteral y Enteral, 27*(5), 1648-1654.

Marcus, D. (2004). Obesity and the impact of chronic pain. *The Clinical Journal of Pain, 20*(3), 186-191.

Martins, S. S., Kim, J. H., Chen, L. Y., Levin, D., Keyes, K. M., Cerdá, M., & Storr, C. L. (2015). Nonmedical prescription drug use among US young adults by educational attainment. *Social Psychiatry and Psychiatric Epidemiology*, *50*(5), 713-724. https://doi.org/10.1007/s00127-014-0980-3

Masheb, R., Lutes, L., Kim, H., Holleman, R., Goodrich, D., Janney, C., . . . Damschroder, L. (2015). Weight loss outcomes in patients with pain. *Obesity, 23*(9), 1778-1784. doi:10.1002/oby.21160

Mattoo, S. K., Chakraborty, K., Basu, D., Ghosh, A., Vijaya, K. K., & Kulhara, P. (2011). Prevalence & correlates of metabolic syndrome in alcohol & opioid dependent inpatients. *The Indian Journal of Medical Research*, *134*(3), 341–348.

Mauro, M., Taylor, V., Wharton, S., & Sharma, A. (2007). Barriers to obesity treatment. *European Journal of Internal Medicine, 19*(2008), 173-180. doi:10.1016/j.ejim.2007.09.011

McCarthy, L., Bigal, M., Katz, M., Derby, C., & Lipton, R. (2009). Chronic pain and obesity in elderly people: results from the Einstein aging study. *Journal of the American Geriatrics Society, 57*(1), 115-119. doi:10.1111/j.1532-5415.2008.02089.x

MedCalc. (2018). MedCalc: Easy to Use Statistical Software. Retrieved from https://www.medcalc.org/calc/relative_risk.php

Meleger, A., Froude, C., & Walker, J. (2014). Nutrition and eating behavior in patients with chronic pain receiving long- term opioid therapy. *Physical Medicine and Rehabilitation, 6*(1), 7-12. doi:10.1016/j.pmrj.2013.08.597

Mertler, C., & Vannatta, Rachel A. (2013). *Advanced and multivariate statistical methods: Practical application and interpretation* (Fifth ed.). Glendale, CA: Pyrczak Publishing.

Messier, S., Mihalko, S., Legault, C., Miller, G. D., Nicklas, B., Devita, P., . . . Loeser, R. (2013). Effects of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis: the IDEA randomized clinical trial. *JAMA, 310*(12), 1263. doi:10.1001/jama.2013.277669

Mollayeva, T., Thurairajah, P., Burton, K., Mollayeva, S., Shapiro, C., & Colantonio, A. (2016). The Pittsburgh Sleep Quality Index as a screening tool for sleep dysfunction in clinical and non-clinical samples: A systematic review and meta-analysis. *Sleep Medicine Reviews, 25*, 52-73. https://doi.org/10.1016/j.smrv.2015.01.009

Morasco, B. J., Duckart, J. P., Carr, T. P., Deyo, R. A., & Dobscha, S. K. (2010). Clinical Characteristics of Veterans Prescribed High Doses of Opioid Medications for Chronic Non-Cancer Pain. *Pain*, *151*(3), 625–632. http://doi.org/10.1016/j.pain.2010.08.002

Morasco, B. J., O'Hearn, D., Turk, D. C., & Dobscha, S. K. (2014). Associations between prescription opioid use and sleep impairment among veterans with chronic pain. *Pain Medicine*, *15*(11), 1902-1910. https://doi.org/10.1111/pme.12472

Mork, P., Vik, K., Moe, B., Lier, R., Bardal, E., & Nilsen, T. (2014). Sleep problems, exercise and obesity and risk of chronic musculoskeletal pain: The Norwegian HUNT study. *The European Journal of Public Health, 24*(6), 924-929. doi:10.1093/eurpub/ckt198

Mundal, I. P., Gråwe, R. W., Bjørngaard, J. H., Linaker, O. M., & Fors, E. A. (2014). Prevalence and long-term predictors of persistent chronic widespread pain in the general population in an 11- year prospective study: the HUNT study. *BMC Musculoskeletal Disorders*, 213. doi:10.1186/1471-2474-15-213

Nahin, R. (2015). Estimates of pain prevalence and severity in adults: United States, 2012. *Jounrnal of Pain, 16*(8): 769-780. doi: 10.1016/j.jpain.2015.05.002

Narouze, S., & Souzdalnitski, D. (2015). Obesity and chronic pain: Systematic review of prevalence and implications for pain practice. *Regional Anesthesia and Pain Medicine, 40*(2), 91-111. doi: 10.1097/AAP.0000000000000218

National Alliance on Mental Illness. (2018). Mental health by the numbers. Retrieved from https://www.nami.org/Learn-More/Mental-Health-By-the-Numbers

National Institute of Health. (2015). Pain intensity: A brief guide to the PROMIS pain intensity instruments. Retrieved from https://www.assessmentcenter.net/documents/PROMIS%20Pain%20Intensity%20Scoring%20Manual.pdf

National Institute of Health. (2015). Pain interference: A brief guide to the PROMIS pain interference instruments. Retrieved from https://www.assessmentcenter.net/documents/PROMIS%20Pain%20Interference%20Scoring%20Manual.pdf

National Institute of Health. (2015). Self-efficacy for managing chronic conditions: A brief guide to the PROMIS self-efficacy instruments. Retrieved from http://www.healthmeasures.net/images/promis/manuals/PROMIS_Self_Efficacy_Scoring_Manual.pdf

Nicholl, B., Smith, D., Cullen, B., Mackay, D., Evans, J., Anderson, J., . . . Mair, F. (2015). Ethnic differences in the association between depression and chronic pain: Cross sectional results from UK Biobank. *BMC Family Practice, 16*, 128. doi:10.1186/s12875-015-0343-5

Obesity Coverage. (2017). Weight loss surgery insurance coverage and costs. Retrieved from https://www.obesitycoverage.com/weight-loss-surgery-insurance-coverage-and-costs/

Ohayon, & Stingl. (2012). Prevalence and comorbidity of chronic pain in the German general population. *Journal of Psychiatric Research, 46*(4), 444-450. https://doi.org/10.1016/j.jpsychires.2012.01.001

Okifuji, A., Donaldson, G., Barck, L., & Fine, P. (2010). Relationship between fibromyalgia and obesity in pain, function, mood, and sleep. *Journal of Pain, 11*(12), 1329. https://doi.org/10.1016/j.jpain.2010.03.006

Okifuji, A., & Hare, B. (2015). The association between chronic pain and obesity. *The Journal of Pain Research, 8*, 399-408. doi:10.2147/JPR.S55598

Olawale, O. A., Ajepe, T. O., Oke, K. I., & Ezeugwa, C. J. (2017). Chronic pain after stroke: A hospital-based study of its profile and correlation with health-related quality of life. *Middle East Journal of Rehabilitation and Health*, *4*(1). E41874 http://dx.doi.org/10.17795/mejrh-41874

Ory, M. G., Ahn, S., Jiang, L., Smith, M. L., Ritter, P. L., Whitelaw, N., & Lorig, K. (2013). Successes of a national study of the chronic disease self-management program: meeting the triple aim of health care reform. *Medical Care*, *51*(11), 992-998. doi: 10.1097/MLR.0b013e3182a95dd1

Peles, E., Schreiber, S., Sason, A., & Adelson, M. (2016). Risk factors for weight gain during methadone maintenance treatment. *Substance Abuse*, *37*(4), 613-618. https://doi.org/10.1080/08897077.2016.1179705

Pells, J., Presnell, K., Edwards, C., Wood, M., Harrison, M., DeCastro, L., . . . Robinson, E. (2005). Moderate chronic pain, weight and dietary intake in African-American adult patients with sickle cell disease. *Journal of the National Medical Association., 97*(12), 1622-1629.

Pells, J. J., Shelby, R. A., Keefe, F. J., Dixon, K. E., Blumenthal, J. A., Lacaille, L., . . . Kraus, V. B. (2008). Arthritis self-efficacy and self-efficacy for resisting eating: Relationships to pain, disability, and eating behavior in overweight and obese individuals with osteoarthritic knee pain. *Pain, 136*(3), 340-347. doi:10.1016/j.pain.2007.07.012

Peltonen, M., Lindroos, A., & Torgerson, J. (2003). Musculoskeletal pain in the obese: A comparison with a general population and long-term changes after conventional and surgical obesity treatment. *Pain, 104*(3), 549-557. https://doi.org/10.1016/S0304-3959(03)00091-5

Peluso, L., & Vanek, V. (2007). Efficacy of Gastric Bypass in the Treatment of Obesity-Related Comorbidities. *Nutrition in Clinical Practice, 22*(1), 22-28. doi:10.1177/011542650702200122

Petereit, R., Jonaitis, L., Kupčinskas, L., & Maleckas, A. (2014). Gastrointestinal symptoms and eating behavior among morbidly obese patients undergoing Roux-en-Y gastric bypass. *Medicina, 50*(2), 118-123. https://doi.org/10.1016/j.medici.2014.06.009

Pettersson, A., Boström, K., Gustavsson, P., & Ekselius, L. (2015). Which instruments to support diagnosis of depression have sufficient accuracy? A systematic review. *Nordic Journal of Psychiatry, 69*(7), 497-508. https://doi.org/10.3109/08039488.2015.1008568

Pohar, M., Blas, M., & Turk, S. (2004). Comparison of logistic regression and linear discriminant analysis: a simulation study. *Metodoloski Zvezki*, *1*(1), 143.

Polfuss, M., Babler, E., Bush, L. L., & Sawin, K. (2015). Family Perspectives of Components of a Diabetes Transition Program. *Journal of Pediatric Nursing, 30*(5), 748. doi:10.1016/j.pedn.2015.05.010

Polit, D., & Beck, Cheryl Tatano. (2016). *Nursing research : Generating and assessing evidence for nursing practice* (Tenth ed.). Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins.

Pories, W. J. (2008). Bariatric Surgery: Risks and Rewards. *The Journal of Clinical Endocrinology & Metabolism, 93*(11), S89-S96. https://doi.org/10.1210/jc.2008-1641

Portney, L., & Watkins, Mary P. (2013). *Foundations of clinical research : Applications to practice* (4th ed.). Upper Saddle River, N.J.: Pearson/Prentice Hall.

Probst, T., Neumeier, S., Altmeppen, J., Angerer, M. Loew, T. & Pieh, E.. (2016). Depressed mood differentially mediates the relationship between pain intensity and pain disability depending on pain duration: A moderated mediation analysis in chronic pain patients. *Pain Research and Management, 2016*(7). http://dx.doi.org/10.1155/2016/3204914

Ramsden, C. E., Faurot, K. R., Zamora, D., Palsson, O. S., MacIntosh, B. A., Gaylord, S., ... & Mann, J. D. (2015). Targeted alterations in dietary n-3 and n-6 fatty acids improve life functioning and reduce psychological distress among chronic headache patients: secondary analysis of a randomized trial. *Pain*, *156*(4), 587. doi:10.1097/01.j.pain.0000460348.84965.47

Ray, L., Lipton, R., Zimmerman, M., Katz, M., & Derby, C. (2011). Mechanisms of association between obesity and chronic pain in the elderly. *Pain, 152*(1), 53-59. https://doi.org/10.1016/j.pain.2010.08.043

Roffey, D., Ashdown, L., Dornan, H., Creech, M., Dagenais, S., Dent, R., & Wai, E. (2011). Pilot evaluation of a multidisciplinary, medically supervised, nonsurgical weight loss program on the severity of low back pain in obese adults. *The Spine Journal, 11*(3), 197-204. https://doi.org/10.1016/j.spinee.2011.01.031

Rogers, K., Kemp, A., McLachlan, A., & Blyth, F. (2013). Adverse Selection? A Multi-Dimensional Profile of People Dispensed Opioid Analgesics for Persistent Non-Cancer Pain. *PLoS ONE*, *8*(12), e80095. http://doi.org/10.1371/journal.pone.0080095

Rothman, K. (2008). BMI-related errors in the measurement of obesity. *International Journal of Obesity, 32*(S3), S56-S59.

Rosenblum, A., Joseph, H., Fong, C., Kipnis, S., Cleland, C., & Portenoy, R. K. (2003). Prevalence and characteristics of chronic pain among chemically dependent patients in methadone maintenance and residential treatment facilities. *JAMA*, *289*(18), 2370-2378. doi:10.1001/jama.289.18.2370

Ryan, P., & Sawin, K. J. (2009). The Individual and Family Self- Management Theory: background and perspectives on context, process, and outcomes. *Nursing Outlook, 57*(4), 217. doi:10.1016/j.outlook.2008.10.00

Ryan, C., Vijayaraman, A., Denny, V., Ogier, A., Ells, L., Wellburn, S., . . . Atkinson, G. (2017). The association between baseline persistent pain and weight change in patients attending a specialist weight management service. *PLoS ONE, 12*(6), E0179227. https://doi.org/10.1371/journal.pone.0179227

Saltiel, A. R., & Olefsky, J. M. (2017). Inflammatory mechanisms linking obesity and metabolic disease. *The Journal of Clinical Investigation*, *127*(1), 1-4. https://doi.org/10.1172/JCI92035.

Sánchez-Lara, K., Ugalde-Morales, E., Motola-Kuba, D., & Green, D. (2013). Gastrointestinal symptoms and weight loss in cancer patients receiving chemotherapy. *The British Journal of Nutrition, 109(*5), 894-7. https://doi.org/10.1017/S0007114512002073

Schumacher, M. (2012). Pain Management for the Obese Sleep Apnea Patient. *Intensive Care Unit Director, 3*(2), 80-84. https://doi.org/10.1177%2F1944451612438918

Schuchat, A., Houry, D., & Guy, G. (2017). New Data on Opioid Use and Prescribing in the United States. *JAMA, 318*(5), 425-426. doi:10.1001/jama.2017.8913

Seal, K. H., Shi, Y., Cohen, G., Cohen, B. E., Maguen, S., Krebs, E. E., & Neylan, T. C. (2012). Association of mental health disorders with prescription opioids and high-risk opioid use in US veterans of Iraq and Afghanistan. *JAMA*, *307*(9), 940-947. doi:10.1001/jama.2012.234

Setchell, J., Watson, B., Jones, L., & Gard, M. (2015a). Weight stigma in physiotherapists: Implications for education, practice and physiotherapy. *Physiotherapy, 101*, E1369 E1370. https://doi.org/10.1016/j.physio.2015.03.1308

Setchell, J., Watson, B., Jones, L., & Gard, M. (2015b). Weight stigma in physiotherapy practice: Patient perceptions of interactions with physiotherapists. *Manual Therapy, 20*(6), 835 841. https://doi.org/10.1016/j.math.2015.04.001

Shade, M. Y., Berger, A. M., Dizona, P. J., Pozehl, B. J., & Pullen, C. H. (2016). Sleep and health-related factors in overweight and obese rural women in a randomized controlled trial. *Journal of Behavioral Medicine*, *39*(3), 386-397. doi:10.1007/s10865-015-9701-y

Shiri, R., Karppinen, J., Leino-Arjas, P., Solovieva, S., & Viikari-Juntura, E. (2009). The association between obesity and low back pain: a meta-analysis. *American Journal of Epidemiology*, *171*(2), 135-154. https://doi.org/10.1093/aje/kwp356

Skeie, G., Mode, N., Henningsen, M., & Borch, K. (2015). Validity of self-reported body mass index among middle-aged participants in the Norwegian Women and Cancer study. *Clinical Epidemiology, 7*, 313. doi:10.2147/CLEP.S83839

Somers, T., Blumenthal, J., Guilak, F., Kraus, V., Schmitt, D., Babyak, M., . . . Keefe, F. (2012). Pain coping skills training and lifestyle behavioral weight management in patients with knee osteoarthritis: A randomized controlled study. *Pain, 153*(6), 1199-1209. https://doi.org/10.1016/j.pain.2012.02.023

Stone, A., & Broderick, J. (2012). Obesity and pain are associated in the United States. *Obesity, 20*(7), 1491. doi:10.1038/oby.2011.397

Sullivan, M. D., Edlund, M. J., Zhang, L., Unützer, J., & Wells, K. B. (2006). Association between mental health disorders, problem drug use, and regular prescription opioid use. *Archives of Internal Medicine*, *166*(19), 2087-2093. doi:10.1001/archinte.166.19.2087

Tanamas, S., Wluka, A., Davies-Tuck, M., Wang, Y., Strauss, B. J., Proietto, J., . . . Cicuttini, F. (2013). Association of weight gain with incident knee pain, stiffness, and functional difficulties: a longitudinal study. *Arthritis Care & Research, 65*(1), 34. doi:10.1002/acr.21745

Thomazeau, J., Perin, J., Nizard, R., Bouhassira, D., Collin, E., Nguyen, E., ... & Lloret□Linares, C. (2014). Pain management and pain characteristics in obese and normal weight patients before joint replacement. *Journal of Evaluation in Clinical Practice*, *20*(5), 611-616. https://doi.org/10.1111/jep.12176

Tietjen, G., Peterlin, B., Brandes, J., Hafeez, F., Hutchinson, S., Martin, V., . . . Khuder, S. (2007). Depression and Anxiety: Effect on the Migraine–Obesity Relationship. *Headache: The Journal of Head and Face Pain, 47*(6), 866-875. doi**:** 10.1111/j.1526-4610.2007.00810.x

Treede, R.-D., Rief, W., Barke, A., Aziz, Q., Bennett, M. I., Benoliel, R., … Wang, S.-J. (2015). A classification of chronic pain for ICD-11. *Pain*, *156*(6), 1003–1007. http://doi.org/10.1097/j.pain.0000000000000160

Turner, J. A., Anderson, M. L., Balderson, B. H., Cook, A. J., Sherman, K. J., & Cherkin, D. C. (2016). Mindfulness-based stress reduction and cognitive behavioral therapy for chronic low back pain: similar effects on mindfulness, catastrophizing, self-efficacy, and acceptance in a randomized controlled trial. *Pain*, *157*(11), 2434-2444. doi:10.1097/j.pain.0000000000000635

United States Census Bureau (2017). American Community Survey 1-year estimates. Retrieved from https://censusreporter.org/profiles/16000US5367000-spokane-wa/

United States Department of Health and Human Services. (2014). Healthy People 2020. Retrieved from https://www.healthypeople.gov/2020/topics-objectives

University of Pittsburg. (n.d.). Pittsburg Sleep Quality Index. Retrieved from http://www.sleep.pitt.edu/research/instruments.html

University of Wisconsin Milwaukee. (2016). Self-Management Science Center- Theory. Retrieved from http://uwm.edu/nursing/about/centers-institutes/selfmanagement/theory/

Urquhart, D. M., Berry, P. E., Wluka, A. J., Strauss, B. B., Wang, Y., Proietto, J., . . . Cicuttini, F. (2011). 2011 Young investigator award winner: Increased fat mass is associated with high levels of low back pain intensity and disability. *Spine, 36*(16), 1320 1325. doi:10.1097/BRS.0b013e3181f9fb66

Vandenkerkhof, E., Macdonald, H., Jones, G., Power, C., & Macfarlane, G. (2011). Diet, lifestyle and chronic widespread pain: results from the 1958 British Birth Cohort Study. *Pain, Research & Management, 16*(2), 87. http://dx.doi.org/10.1155/2011/727094

Vincent, H. K., Adams, M. C., Vincent, K. R., & Hurley, R. W. (2013). Musculoskeletal pain, fear avoidance behaviors, and functional decline in obesity: potential interventions to manage pain and maintain function. *Regional Anesthesia and Pain Medicine*, *38*(6), 481 491. doi:10.1097/AAP.0000000000000013

Wang, Y., & Beydoun, M. A. (2007). The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. *Epidemiologic Reviews*, *29*(1), 6-28. https://doi.org/10.1093/epirev/mxm007

Wang, X. M., Hamza, M., Wu, T. X., & Dionne, R. A. (2009). Upregulation of IL-6, IL-8 and CCL2 gene expression after acute inflammation: Correlation to clinical pain. *Pain*, *142*(3), 275-283. doi:10.1016/j.pain.2009.02.001

Weiss, R., Potter, J., Griffin, M., McHugh, R., Haller, D., Jacobs, P., . . . Rosen, K. (2014). Reasons for opioid use among patients with dependence on prescription opioids: The role of chronic pain. *Journal of Substance Abuse Treatment, 47*(2), 140-145. https://doi.org/10.1016/j.jsat.2014.03.004

Williams, A. C., Eccleston, C., & Morley, S. (2012). Psychological therapies for the management of chronic pain (excluding headache) in adults. *The Cochrane Database of Systematic Reviews, 2009*(2):CD007407. doi:10.1002/14651858.CD007407.pub2

Wilson, M. (2014). Integrating the Concept of Pain Interference into Pain Management. *Pain Management Nursing, 15*(2), 499-505. https://doi.org/10.1016/j.pmn.2011.06.004

Wilson, M., & Shaw, M. (2017). "Focus on the Good"-Participant Perspectives after Engaging in an Online Pain Self-Management Program. In *Proceedings of the 50th Hawaii International Conference on System Sciences*. doi:10.24251/HICSS.2017.408

Wright, L., Schur, E., Noonan, C., Ahumada, S., Buchwald, D., & Afari, N. (2010). Chronic pain, overweight, and obesity: findings from a community-based twin registry. *Journal of Pain, 11*(7), 628. https://doi.org/10.1016/j.jpain.2009.10.004

Xiang, A., Cheng, K., Shen, X., Xu, P., & Liu, S. (2017). The immediate analgesic effect of acupuncture for pain: a systematic review and meta-analysis. *Evidence-Based Complementary and Alternative Medicine*, *2017,* 1-13. https://doi.org/10.1155/2017/3837194

Yanev N, & Vlaskovska M. (2016). Pain in Obesity is not Obesity and Pain. *Journal of International Medical Association Bulgaria, 22*(1):1072-1074. http://dx.doi.org/10.5272/jimab.2016221.1072

Younger, J., McCue, R., & Mackey, S. (2009). Pain outcomes: A brief review of instruments and techniques. *Current Pain and Headache Reports, 13*(1), 39-43. https://doi.org/10.1007/s11916-009-0009-x

Zdziarski, L., Wasser, J., & Vincent, H. (2015). Chronic pain management in the obese patient: a focused review of key challenges and potential exercise solutions. *Journal of Pain Research, 8*, 63-77. doi:10.2147/JPR.S55360

Zhao, G., Ford, E., Dhingra, S., Li, C., Strine, T. & Mokdad, A. (2009). Depression and anxiety among US adults: Associations with body mass index. *International Journal of Obesity*, *33*(2), 257. https://doi.org/10.1038/ijo.2008.268

Zheng, H., & Chen, C. (2015). Body mass index and risk of knee osteoarthritis: Systematic review and meta-analysis of prospective studies. *BMJ Open*, *5*(12), e007568. doi:10.5061/dryad.j4d8r

APPENDIX A

MEASURES

Depression: Patient Health Questionnaire (PHQ-8)

Over the **last 2 weeks**, how often have you been bothered by any of the following problems? *(circle **one** number on each line)*

How often during the past 2 weeks were you bothered by...	**Not at all**	**Several days**	**More than half the days**	**Nearly every day**
1. Little interest or pleasure in doing things	0	1	2	3
2. Feeling down, depressed, or hopeless	0	1	2	3
3. Trouble falling or staying asleep, or sleeping too much	0	1	2	3
4. Feeling tired or having little energy	0	1	2	3
5. Poor appetite or overeating	0	1	2	3
6. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down	0	1	2	3
7. Trouble concentrating on things, such as reading the newspaper or watching television	0	1	2	3
8. 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	0	1	2	3

Total Severity Score (PHQ-8)	
0-4	Minimal depression
5-9	Mild depression
10-14	Moderate depression
15-19	Moderately severe depression
20-24	Severe depression

APPENDIX A

MEASURES

Self-Efficacy for Managing Symptoms-PROMIS Short Form

Please respond to each item by marking one box per row. **CURRENT level of confidence…**	**I am not at all confident**	**I am a little confident**	**I am somewhat confident**	**I am quite confident**	**I am very confident**
I can manage my symptoms during my daily activities.	**1**	**2**	**3**	**4**	**5**
I can keep my symptoms from interfering with relationships with friends	**1**	**2**	**3**	**4**	**5**
I can manage my symptoms in a public place.	**1**	**2**	**3**	**4**	**5**
I can work with my doctor to manage my symptoms.	**1**	**2**	**3**	**4**	**5**

MANAGING SYMPTOMS **4-Item Short Form** *Short Form Conversion Table*		
Raw Score	T-score	SE
4	24.93	4.44
5	28.72	3.32
6	30.87	3.07
7	32.85	2.87
8	34.64	2.78
9	36.34	2.78
10	37.99	2.80
11	39.59	2.82
12	41.16	2.86
13	42.79	2.93
14	44.56	2.97
15	46.41	2.96
16	48.27	2.97
17	50.26	3.09
18	52.75	3.37
19	55.90	3.71
20	62.12	5.73

SE=Standard Error

APPENDIX A

MEASURES

Sleep Quality: Pittsburg Sleep Quality Index

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

1. During the past month, what time have you usually gone to bed at night? ____________________
2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? ___________
3. During the past month, what time have you usually gotten up in the morning? ____________________
4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) ____________________

5. During the past month, how often have you had trouble sleeping because you…	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				
6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?				
	Very good	Fairly good	Fairly bad	Very bad
9. During the past month, how would you rate your sleep quality overall?				

APPENDIX A

MEASURES

Scoring the PSQI

The order of the PSQI items has been modified from the original order in order to fit the first 9 items (which are the only items that contribute to the total score) on a single page. Item 10, which is the second page of the scale, does not contribute to the PSQI score.

In scoring the PSQI, seven component scores are derived, each scored 0 (no difficulty) to 3 (severe difficulty). The component scores are summed to produce a global score (range 0 to 21). Higher scores indicate worse sleep quality.

Component 1: Subjective sleep quality—question 9

Response to Q9	Component 1 score
Very good	0
Fairly good	1
Fairly bad	2
Very bad	3

Component 1 score:_____

Component 2: Sleep latency—questions 2 and 5a

Response to Q2	Component 2/Q2 subscore
$\leq$ 15 minutes	0
16-30 minutes	1
31-60 minutes	2
> 60 minutes	3

Response to Q5a	Component 2/Q5a subscore
Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Sum of Q2 and Q5a subscores	Component 2 score
0	0
1-2	1
3-4	2
5-6	3

Component 2 score:_____

Component 3: Sleep duration—question 4

Response to Q4	Component 3 score
> 7 hours	0
6-7 hours	1
5-6 hours	2
< 5 hours	3

Component 3 score:_____

Component 4: Sleep efficiency—questions 1, 3, and 4

Sleep efficiency = (# hours slept/# hours in bed) X 100%

hours slept—question 4

hours in bed—calculated from responses to questions 1 and 3

Sleep efficiency	Component 4 score
> 85%	0
75-84%	1
65-74%	2
< 65%	3

Component 4 score:_____

APPENDIX A

MEASURES

Component 5: Sleep disturbance—questions 5b-5j

Questions 5b to 5j should be scored as follows:

Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Sum of 5b to 5j scores	Component 5 score
0	0
1-9	1
10-18	2
19-27	3

Component 5 score:_____

Component 6: Use of sleep medication—question 6

Response to Q6	Component 6 score
Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Component 6 score:_____

Component 7: Daytime dysfunction—questions 7 and 8

Response to Q7	Component 7/Q7 subscore
Not during past month	0
Less than once a week	1
Once or twice a week	2
Three or more times a week	3

Response to Q8	Component 7/Q8 subscore
No problem at all	0
Only a very slight problem	1
Somewhat of a problem	2
A very big problem	3

Sum of Q7 and Q8 subscores	Component 7 score
0	0
1-2	1
3-4	2
5-6	3

Component 7 score:_____

Global PSQI Score: Sum of seven component scores:___________

Citation: Buysse, DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ: The Pittsburgh Sleep Quality Index (PSQI): A new instrument for psychiatric research and practice. Psychiatry Research 28:193-213, 1989

APPENDIX A

MEASURES

Pain Interference-PROMIS Short Form

Please respond to each question or statement by marking one box per row. **In the past 7 days…**	**Not at all**	**A little bit**	**Somew hat**	**Quite a bit**	**Very much**
How much did pain interfere with your day to day activities?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with work around the home?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with your ability to participate in social activities?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with your household chores?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with the things you usually do for fun?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with your enjoyment of social activities?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with your enjoyment of life?	**1**	**2**	**3**	**4**	**5**
How much did pain interfere with your family life?	**1**	**2**	**3**	**4**	**5**

APPENDIX A

MEASURES

Pain Interference 8a - Adult v1.0		
Short Form Conversion Table		
Raw Score	T-Score	SE*
8	40.7	5.9
9	47.9	2.4
10	49.9	1.8
11	51.2	1.5
12	52.3	1.4
13	53.2	1.4
14	54.1	1.4
15	55.0	1.4
16	55.8	1.4
17	56.6	1.4
18	58.1	1.3
19	58.1	1.3
20	58.8	1.3
21	59.5	1.3
22	60.2	1.3
23	60.8	1.3
24	61.5	1.3
25	62.1	1.3
26	62.8	1.3
27	63.5	1.3
28	64.1	1.3
29	64.8	1.3
30	65.5	1.3
31	66.2	1.3
32	66.9	1.3
33	67.7	1.3
34	68.4	1.3
35	69.2	1.3
36	70.1	1.4
37	71.0	1.4
38	72.1	1.6
39	73.5	2.0
40	77.0	3.5

*SE = Standard Error on T-Score

APPENDIX A

MEASURES

Pain Intensity-PROMIS subscale

Please respond to each item by marking one box per row. **In the past 7 days…**	**Had no pain**	**Mild**	**Moderate**	**Severe**	**Very severe**
How intense was your pain at its worst?	**1**	**2**	**3**	**4**	**5**
How intense was your average pain?	**1**	**2**	**3**	**4**	**5**
What is your level of pain right now?	**1**	**2**	**3**	**4**	**5**

Pain Intensity 3a		
Short Form Conversion Table		
Raw Score	T Score	SE*
3	30.7	4.5
4	36.3	3.1
5	40.2	3
6	43.5	3
7	46.3	3
8	49.4	2.9
9	52.1	2.8
10	54.5	2.9
11	57.5	3.1
12	60.5	3.1
13	64.1	3.8
14	67.4	4.2
15	71.8	5

*SE=Standard Error on Tscore metric