

Sleep Disturbance and Pain in an Obese Residential Treatment-seeking Population

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Background: The relationships between body mass index (BMI) and sleep disturbance, sleep disturbance and pain, and obesity and pain are documented; however, there is a paucity of research exploring how sleep relates to pain in obese populations.

Method: The participants comprised 386 (234 women, 152 men) obese (BMI $M = 40.7$) adult (age $M = 51.0$ y) patients enrolling in a 4-week residential obesity treatment program. All information was gathered as part of the initial program evaluation.

Results: The prevalence of patients reporting at least 1 disturbed sleep symptom was 84.8%. The prevalence of patients reporting at least 1 type of pain was 83.4%. After controlling for depression, anxiety, BMI, age, and sleep apnea treatment, regression analyses showed that daytime sleepiness, night sweats ($P < 0.01$), difficulties falling asleep, and difficulties staying asleep ($P < 0.05$) predicted the total number of pain symptoms reported by women. Among men, controlling for the same variables, fatigue ($P < 0.01$), night sweats, and difficulty falling asleep ($P < 0.05$) predicted the number of pain symptoms reported.

Discussion: These results suggest that in this obese population, disturbed sleep and pain are related, and that this relationship may be different in men and women. Given the prevalence of pain and disturbed sleep in obese populations, this represents a valuable first step in better understanding this relationship.

Key Words: pain, sleep, obesity, weight loss treatment, BMI, mood
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Sleep disturbances¹ and elevated pain levels² are frequently noted in obese populations. However, there is little research exploring both pain and sleep issues in obese treatment-seeking populations.

SLEEP AND PAIN

Previous research suggests that pain may reduce the quantity and quality of sleep,³ and, conversely, disturbed sleep may increase pain.⁴ The National Sleep Foundation Sleep in America Survey included over 1500 older (> 55 y) adults, interviewed by telephone.⁵ In this study, body pain

was significantly related to symptoms of disturbed sleep, including difficulty falling asleep, multiple nighttime awakenings, waking too early, waking feeling unrefreshed, daytime sleepiness, snoring, restless leg symptoms, and insufficient sleep (< 6 h/night).

Additionally, in healthy adults, certain types of poor-quality sleep have been shown to increase pain levels.^{4,6} In the now classic study by Moldofsky and Scarisbrick,⁴ young, healthy individuals were divided into 2 groups. The first group was deprived of δ -wave (stages 3 to 4) sleep; the second group was deprived of REM-stage sleep. The group deprived of δ -wave sleep reported significantly more musculoskeletal symptoms, including joint pain, muscle pain, muscle tenderness, and muscle stiffness, as well as increased incidences of headache as compared with the group deprived of REM sleep, who did not show significant changes in physical symptoms. As δ -wave, or slow-wave, sleep is known to be related to the repair of damaged tissues and efficient immune system response, intuitively one might conclude that sleep difficulties may create a vicious and reciprocal cycle of increased pain sensitivity and worsening sleep quality and quantity.

OBESITY AND SLEEP

In recent years, the relationship between BMI and sleep disturbance has drawn increased attention in the literature. Elevated BMI has been associated with sleep apnea,¹ night eating,⁷ insomnia,⁸ long-term voluntary sleep restriction,⁹ and reduced sleep quantity.¹⁰ In the recent Wisconsin Sleep Cohort Study that examined sleep in over 1000 community participants,¹⁰ researchers found that as sleep quantity decreased, ghrelin levels increased and leptin levels decreased. This hormonal pattern is associated with increased appetite, decreased energy expenditure, and weight gain. Furthermore, although the research on sleep architecture and obesity is limited, there is some evidence that points to a relationship between elevated BMI and a decrease in slow-wave sleep.¹¹ A logical conclusion to the combined results of these findings suggests that reductions in both quality and quantity of sleep may be related to increased weight gain and obesity.

OBESITY AND PAIN

Obese individuals commonly experience comorbid chronic pain.^{2,12} As part of a national survey on health promotion, over 5600 individuals aged 16 to 64 years completed a self-report mailed survey on health attitudes and behaviors, and were examined according to BMI category. Analyses showed that among both men and women, those in higher BMI categories reported a higher prevalence of physical pain.¹²

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In another population-based study comparing over 6000 obese individuals to approximately 1100 normal-weight individuals, researchers found that obese individuals experience substantially higher rates of body pain.¹³ Obese women, compared with normal-weight women, experienced significantly more neck pain (45% vs. 24%), back pain (41% vs. 20%), hip pain (27% vs. 8%), knee pain (36% vs. 7%), ankle pain (31% vs. 4%), and any pain (68% vs. 37%; $P < 0.001$), respectively. Similarly, compared with their normal weight counterparts, obese men were more likely to experience neck pain (31% vs. 15%), back pain (34% vs. 21%), hip pain (16% vs. 4%), knee pain (29% vs. 9%), ankle pain (20% vs. 5%), and any pain (58% vs. 32%; $P < 0.001$). Clearly, as individuals increase in BMI, they are at higher risk for increased pain.

OTHER FACTORS INFLUENCING PAIN PERCEPTION

Sex

Although elevated BMI is associated with increased pain in both men and women, it is important to note that the experience of pain may be different for each sex. A literature review by Unruh¹⁴ found that women are more likely than men to report greater frequency, severity, and duration of pain. Interestingly, women were also more likely to respond to pain by actively addressing related health issues, such as obesity.¹⁴ These findings highlight the importance of considering each sex separately when addressing these issues.

Psychosocial

Mood disorders negatively impact both pain and sleep.¹⁵⁻¹⁷ In a comprehensive literature review of depression and pain, it was noted that researchers have consistently found that mood, pain, and sleep difficulties co-occur. Evidence suggests that this co-occurrence may be due in part to shared neurotransmitter pathways.¹⁸ Emotional status should therefore be considered when examining issues of pain and sleep.

Age

Age may also impact the experience of pain. As people age, pain perception often decreases.¹⁹ However, while individuals may become less sensitive to pain as they age, they are more likely to report that pain interferes with their daily activities.²⁰ Age-related medical issues can also create sleep disruptions that may differentially impact older age groups.²¹ As age may impact both pain perception and sleep, it too should be considered when exploring relationships between these variables.

CURRENT STUDY

Despite the increased interest in links among obesity, sleep disturbances, and pain, there is a paucity of research exploring the relationships between sleep and pain in obese populations. Moreover, the evidence suggesting differential impacts of various types of sleep disturbance on pain highlights the need for research examining specific sleep symptoms and their relationship to pain in obese populations. In this exploratory study, we sought to achieve the following in an obese treatment-seeking population: (1) characterize the relationship between disturbed sleep and pain; (2) identify the relationship between specific symp-

oms of disturbed sleep and reported pain; and (3) explore these relationships separately for men and women.

METHOD

Setting

Data were collected as part of the routine intake assessment at a multidisciplinary residential lifestyle change-focused treatment program for obesity in Durham, NC. The program includes assessment, education, and intervention in 4 areas: medical, nutrition, fitness, and behavioral health. Adults participate in an intensive program including lectures, group classes, individual counseling, meals, and exercise at this one site.

Participants

The participants consisted of a nonrandomized consecutive sample of all new patients who attended the program. Inclusion criteria were as follows: (1) first-time program attendee, (2) attending the standard 4-week program, (3) complete baseline data, and (4) over the age of 18 years. The participant sample included 386 obese ($M = 40.7$ BMI ± 10.12) adults ($M = 51.0$ years ± 16.29). The sample was 60.6% female. The female subgroup had a mean age of 50.8 years (± 16.10), and were obese ($M = 38.9$ BMI ± 9.41). The male subgroup comprised 39.4% of the sample, with a mean age of 51.2 years (± 16.61), and were obese ($M = 43.2$ BMI ± 10.62).

Procedure

The patients were identified as part of a retrospective chart review. The initial review included 437 patients (262 women; 175 men). Twenty-eight women and 23 men were removed due to missing data. This left a total of 386 patients in the sample (234 women, 152 men) for analysis. Data were gathered from self-report questionnaires that were completed immediately before arrival at the program and reviewed by professional staff during the intake assessment process. The Duke University Medical Center Institutional review board granted this study exempt status as a de-identified chart review of archival data.

Measures

Pain

All the patients were asked to respond according to "current or recent" presence or absence (yes/no) of each of the following possible pain complaints on a medical questionnaire: chest pain (cardiac), chest pain (respiratory), joint pain, headache, leg pain, muscle pain, abdominal pain, back pain, and urinary pain. In addition, men were provided an item inquiring about testicular pain, and women were provided an item for each of breast pain and pain during intercourse. In total, there were possible items were 10 for men and 11 for women. Total pain score was calculated by summing the number of individual pain sites endorsed and dividing this number by the number of possible pain symptoms available to each sex. By expressing the total pain score as a percentage, it standardized the scores to allow for analysis of the entire sample. Endorsement frequencies for the pain items were as follows: 7.5% cardiac chest pain, 4.0% respiratory chest pain, 54.7% joint pain, 27.9% headache, 24.2% leg pain, 37.4% muscle pain, 9.5% abdominal pain, 54.8% back pain, 2% urinary pain, 1.3% testicular pain (men only), 4.8% breast pain (women only), and 12.8% pain during intercourse (women only).

Disturbed Sleep

On a medical questionnaire, patients were asked to respond according to the “current or recent” presence or absence (yes/no) of the following indicators of disturbed sleep: diagnosed sleep apnea, fatigue, night sweats, difficulty in falling asleep, difficulty staying asleep, frequent, and or loud snoring, spells of not breathing while sleeping, excessive daytime sleepiness, and waking from sleep feeling smothered from lack of air.

To receive the diagnosis of sleep apnea, verifiable sleep study (polysomnography) was required. The participants were also asked to indicate whether they were currently using sleep apnea treatment [ie, continuous positive airway pressure (CPAP) or other similar treatments]. This information was used in the analyses to control for the potential influence of these factors on the observed relationships between pain and sleep.

The Total Sleep Disturbance Score is the number of disturbed sleep items endorsed by each individual. There were 9 total possible items for both men and women (see Table 1 for endorsement frequencies).

Mood

The Hospital Anxiety and Depression Scale²² (HADS) was used to assess current anxiety or depression symptoms. The scale consists of 14 questions (7 assessing anxiety, 7 assessing depression). Each question is answered on a 0 to 3 scale, with higher scores indicating greater emotional distress. A score above 7 on either scale indicates a potential area of clinical concern. The HADS provides acceptable validity and specificity (HADS-Anxiety Cronbach $\alpha = 0.83$, HADS-Depression $\alpha = 0.82$). In previous research,²³ the HADS shows an interscale correlation of 0.56, and concurrent validity with other psychiatric scales ranging from 0.49 to 0.83.

Data Analysis

We examined the associations between pain, as measured by total number of self-reported pain symptoms, and symptoms related to sleep disturbance. Analyses were

performed on the entire sample, and on the 2 sex subsamples. We used SPSS v. 15²⁴ to identify the relationship between sleep disturbance and pain complaints with the following 4 analytical steps.

Step 1: Correlation Between Sleep Disturbance and Pain

A Spearman ρ correlation was performed using Total Sleep Disturbance Score by Total Pain Score, to identify whether a relationship exists between our 2 primary variables for the entire sample. The resulting ρ was squared to provide uniform presentation of the data across the data analysis steps. The same procedure was then used on the men-only subgroup and the women-only subgroup.

Step 2: Relationship Adjusting for Potential Confounders

An entry-method linear regression was performed using the entire sample between Total Sleep Disturbance Score by Total Pain Score while adjusting for age, BMI, depression, anxiety, and CPAP use. The same procedure was then used on a men-only subgroup and a women-only subgroup.

Step 3: Relationship Between Specific Sleep Disturbances and Pain

A correlation matrix was developed with all sleep disturbance variables that comprise the Total Sleep Disturbance Score to test for multicollinearity.

Step 4: Relationship Between Specific Sleep Disturbances and Pain Adjusting for Potential Confounders

A backward linear regression equation was performed to identify the relationship between individual sleep disturbances and the Total Pain Score. Analysis was completed for the entire sample and then for each of the sex subgroups. Adjusted variables were entered in step 1; individual sleep disturbances were entered in step 2 of the equation. Removal criteria were set at $P = 0.10$.

TABLE 1. Clinical Characteristics of the Patient Population

| | Sample <i>M</i> (SD) | Men | Women |
|--|----------------------|--------------|--------------|
| Age (y) | 51.0 (16.29) | 51.2 (16.61) | 50.8 (16.10) |
| BMI (kg/m ²) | 40.7 (10.12) | 43.2 (10.62) | 38.9 (9.41) |
| Patients reporting at least 1 pain site | 83.4% | 77.0% | 87.6% |
| Total Pain Score | 22.1 (16.87) | 19.7 (16.39) | 23.6 (17.04) |
| Patients reporting at least 1 disturbed sleep symptom | 84.8% | 87.3% | 83.1% |
| Diagnosed sleep apnea | 28.0% | 48.8% | 14.1% |
| Fatigue | 57.5% | 60.0% | 58.4% |
| Night sweats | 20.2% | 13.3% | 24.7% |
| Difficulty falling asleep | 30.4% | 29.7% | 30.9% |
| Difficulty staying asleep | 41.4% | 41.8% | 41.2% |
| Frequent/loud snoring | 42.1% | 56.3% | 32.9% |
| Not breathing during sleep | 23.2% | 34.8% | 15.6% |
| Daytime sleepiness | 23.4% | 28.5% | 20.2% |
| Waking feeling smothered | 8.7% | 10.8% | 7.4% |
| Total Sleep Disturbance Score | 2.7 (2.08) | 3.2 (2.09) | 2.5 (2.03) |
| CPAP treatment | 20.4% | 34.6% | 11.1% |
| Patients endorsing both pain and sleep disturbance items | 73.8% | 71.1% | 75.6% |
| Anxiety (HADS)* | 6.9 (3.80) | 6.3 (3.71) | 7.3 (3.82) |
| Depression (HADS)* | 6.1 (4.06) | 6.0 (3.76) | 6.1 (4.24) |

*HADS indicates Hospital Anxiety and Depression Scale scoring: 0 to 7 normal; 8 to 10 mild; 11 to 14 moderate; 15 to 21 severe.²²

RESULTS

Clinical Characteristics of Sample

Both sleep disturbances and pain were prevalent in this population of severely obese treatment-seekers (Table 1).

Step 1: Correlation Between Sleep Disturbance and Pain

A relationship was identified between the total number of sleep disturbances and the total number of pain symptoms ($r^2 > 0.15$, $P < 0.01$) for the entire sample. This relationship was also found for each sex subsample (women: $r^2 > 0.22$, $P < 0.01$; men: $r^2 > 0.11$, $P < 0.01$).

Step 2: Relationship Adjusting for Potential Confounders

The association between sleep disturbance and pain changed very little after adjusting for potential confounders. After adjustments for age, BMI, depression, anxiety, and CPAP use for the entire sample, we found that the adjustment variables had limited ability to account for the variance in total pain symptoms ($r^2 = 0.076$, $P < 0.01$). Adding Total Sleep Disturbance Symptoms to the model improved the prediction value of the model ($r^2 = 0.199$, $P < 0.01$). In the full model, only Anxiety ($B = 0.65$, $SE = 0.327$, $P < 0.05$) and Total Sleep Disturbance ($B = 3.43$, $SE = 0.596$, $P < 0.01$) remained significant.

Men

After adjusting for age, BMI, depression, anxiety, and CPAP use for the men-only subgroup, we found that the adjustment variables continued to have a limited ability to account for the variance in total pain symptoms ($r^2 = 0.11$, $P < 0.01$). Adding Total Sleep Disturbance Symptoms to the model improved the prediction value of the model ($r^2 = 0.273$, $P < 0.01$). In the full model, we again found that only Anxiety ($B = 0.85$, $SE = 0.399$, $P < 0.05$) and Total Sleep Disturbance ($B = 4.00$, $SE = 0.736$, $P < 0.01$) remained significant.

Women

Among the women-only sample, after adjusting for age, BMI, depression, anxiety, and CPAP use, we found that the adjustment variables again played a limited role in accounting for the variance in total pain symptoms ($r^2 = 0.085$, $P = NS$). Adding Total Sleep Disturbance Symptoms to the model improved the prediction value of the model ($r^2 = 0.13$, $P < NS$). In the full model, only Total Sleep Disturbance ($B = 2.11$, $SE = 1.043$, $P < 0.05$) remained significant.

Step 3: Relationship Between Specific Sleep Disturbances and Pain

No highly intercorrelated pairs ($r^2 > 0.6$) were identified among the disturbed sleep symptoms, suggesting that these were indeed tapping unique and differentiated sleep constructs.

Step 4: Relationship Between Specific Sleep Disturbances and Pain Adjusting for Potential Confounders

Backward regression analysis showed that for the entire sample, 4 sleep symptoms significantly predicted total pain symptoms: fatigue, night sweats, difficulty falling asleep, and awakening feeling smothered (Table 2).

TABLE 2. Final Step of Backward Regression of Individual Sleep Disturbances Related to Total Pain for the Entire Sample

| | Total Pain Symptoms | |
|-----------------------------|---------------------|------|
| | B | SE B |
| Constant | 13.62 | 1.72 |
| Fatigue | 6.89* | 2.20 |
| Night sweats | 9.86† | 2.53 |
| Difficulty falling asleep | 8.43† | 2.25 |
| Awakening feeling smothered | 9.78* | 3.56 |
| Adj R ² = 0.232 | | |
| * < 0.01. | | |
| † < 0.001. | | |

Women

Among women, the same analysis showed that night sweats, difficulty falling asleep, difficulty staying asleep, and daytime sleepiness were significantly related to total pain symptoms (Table 3).

Men

Among men, 3 significant sleep disturbances emerged as related to pain: fatigue, night sweats, and difficulty falling asleep (Table 4).

DISCUSSION

Sleep disturbances and pain were found to cooccur frequently in this sample of obese treatment-seeking patients. When considering the entire sample, several different symptoms of disturbed sleep were related to the experience of pain, including fatigue, night sweats, difficulty falling asleep, and awakening feeling smothered. Although the relationship between sleep and pain appears to be different in men and women in some respects, in others there was similarity. For both men and women, night sweats and difficulty falling asleep were associated with self-reported pain symptoms. Additionally, for men fatigue, and for women daytime sleepiness and difficulty staying asleep were related to the number of reported pain symptoms, even after adjusting for CPAP use.

The specific sleep disruptions related to pain for both men and women in this study seems to be consistent with existing literature. Night sweats most frequently occur during non-REM sleep, interrupting δ -wave sleep.²⁵ As disruptions in δ -wave sleep have been linked to increased pain sensations,⁴ it seems likely that there may be a physiologic connection between the increased night sweats

TABLE 3. Final Step of Backward Regression of Individual Sleep Disturbances Related to Total Pain for the Women Subgroup

| | Total Pain Symptoms | |
|----------------------------|---------------------|------|
| | B | SE B |
| Constant | 14.25* | 1.86 |
| Night sweats | 8.61† | 3.03 |
| Difficulty falling asleep | 6.69‡ | 3.22 |
| Difficulty staying asleep | 7.12‡ | 3.12 |
| Daytime sleepiness | 10.29† | 3.33 |
| Adj R ² = 0.265 | | |
| * < 0.001. | | |
| † < 0.01. | | |
| ‡ < 0.05. | | |

TABLE 4. Final Step of Backward Regression of Individual Sleep Disturbances Related to Total Pain for the Men Subgroup

| | Total Pain Symptoms | |
|----------------------------|---------------------|------|
| | B | SE B |
| Constant | 13.84 | 2.67 |
| Fatigue | 9.85* | 3.42 |
| Night sweats | 11.41† | 5.32 |
| Difficulty falling asleep | 6.76† | 3.60 |
| Adj R ² = 0.197 | | |

* < 0.01.
† < 0.05.

and pain observed in this population. Future research should examine behavioral interventions to reduce night sweats-related sleep disturbances (eg, paced respiration)²⁶ and assess these interventions' effect on both this sleep disturbance and, consequently, pain. These findings may be helpful in informing future clinical applications.

Another observed connection in the literature between pain and disturbed sleep is sleep-onset insomnia. Chronic pain can delay sleep onset.³ Therefore, onset insomnia may be part of a cyclical pattern of poor sleep leading to elevated pain and subsequently poorer sleep. Onset insomnia, as captured by the item "difficulty falling asleep" in the present study, was clearly related to pain in this population for both men and women. The strength of this association suggests that this may be a fruitful avenue to pursue when treating the obese patient, particularly in the context of an already extensive literature indicating the impact of sleep onset insomnia on overall health and well-being.²⁷ Additionally, further research to better understand the unique relationship between this sleep disturbance and pain in obese populations is warranted.

In our study, a relationship was found between difficulty staying asleep and the experience of pain in women. Although it is unknown why this particular sleep disturbance was only found in women in this study, previous research has shown that pain patients frequently experience sleep-maintenance insomnia and frequent awakenings.¹⁵ Sleep-maintenance insomnia has been found to be related to increased physiologic reactivity to stress.²⁸ Given that chronic pain is biologically stressful, patients may have increased nighttime awakenings subsequent to this psychophysiologic stressor. Although we are unable to determine from this study whether this relationship is simply due to the physiologic effects of chronic pain or whether there is a unique contribution related to the presence of obesity, evidence suggests that there are links between elevated stress levels and eating behavior that leads to weight gain.^{29,30} Additionally, higher levels of stress may in fact influence visceral (abdominal) fat storage, which is related to higher health risk.²⁹ Further exploration of this phenomenon and potential sex differences related to sleep maintenance insomnia is necessary to fully understand these relationships. Given the documented efficacy of interventions, such as biofeedback in stress management, particularly in reducing physiologic reactivity and the stress response in chronic pain³¹ and disturbed sleep populations,³² coupled with their ability to provide generalized stress reduction,³³ it seems prudent to incorporate such interventions into obesity treatments, particularly for those individuals experiencing sleep disturbance and pain.

Frequent awakenings and sleep-maintenance insomnia is the most frequent symptoms of those with undiagnosed, or undertreated, sleep apnea.³⁴ The present study adjusted for sleep apnea treatment and included the diagnosis of sleep apnea as a sleep disturbance variable to account for untreated sleep apnea in examining this issue. However, the limitation remains that we were unable to fully account for adequacy and elevated reporting of adherence to CPAP treatment. As previous research has shown that consistent and clinically appropriate CPAP use can decrease nighttime awakenings³⁵ and pain reports,¹² attending to the adequacy of the intervention being used to treat sleep apnea and providing access to behavioral intervention to maximize adherence to treatment may be important considerations for future studies.

Daytime sleepiness (women) and fatigue (men) were related to pain in this population as well. Fatigue/sleepiness could potentially contribute to an increased experience of pain if it prevents individuals from actively coping with their pain (eg, performing prescribed physical therapy exercises). However, the most likely explanation for this finding is that daytime fatigue/sleepiness occurs as a consequence of pain, as opposed to being a contributor. Pain can influence sleep quantity and or quality. As discussed previously, pain can delay sleep onset, resulting in a sleep deficit and daytime sleepiness or fatigue.³ In addition, although we were unable to account for medication usage in this study, some common medications prescribed to treat pain or induce sleep can also alter sleep architecture, resulting in less restorative sleep and thus inducing daytime sleepiness, which may have had an influence here.^{36,37}

In addition to those mentioned previously, another limitation of the current study that warrants consideration is the lack of validated instruments to assess pain and sleep disturbances. Unfortunately, this level of assessment was not available to the researchers due to this study being based on a retrospective chart review using items typically included in the clinical assessment packet to identify pain and sleep symptoms. We also recognize our inability to assess intensity of the reported symptoms as a shortcoming. However, although these issues may have limited our ability to obtain detailed pain and sleep information and limited diagnostic specificity, the information obtained is nonetheless useful in light of both the preliminary nature of the study and the paucity of available research on the topic. Furthermore, the type of information used in this study is consistent with the level of data often found in general clinical settings. Clinical settings rarely use validated measures for pain and sleep, and commonly ask simple yes/no questions to endorse symptoms. This level of information is readily gathered in general clinical settings, and requires no specialized training or instruments. Furthermore, it is noteworthy that despite the rudimentary level of evaluation, significant relationships emerged. These findings highlight the value of asking basic pain and sleep questions in busy clinical settings as an initial screening, followed by the use of standardized sleep and pain measures for a second-level assessment, and appropriate referral to further assess these issues.

The notable strengths of this study include the use of validated questionnaires to measure mood disturbances (eg, anxiety and depression), direct measurement of weight in a clinical setting, significant proportion of men, and large sample size. Most importantly, this study represents a first

step in addressing an essential and emergent issue in obesity treatment. These data provide an excellent foundation upon which to build future studies, and a credible argument for clinicians to consider assessing for sleep disorders such as sleep-related breathing disorders and insomnia in their obese patients.

In summary, to date, little has been done to look comprehensively at the interrelationships among pain, sleep, and obesity. Given the prevalence of pain in obese populations (particularly severely obese populations) coupled with recent research linking sleep and obesity, it is critical to develop a clear understanding of the relationships among sleep, pain, and obesity. By continuing to explore the interrelationships among these conditions, researchers and clinicians may be able to improve the quality of life for obese patients, and enhance treatment outcomes and long-term efficacy of weight-loss programs. A natural extension of this study would be to integrate validated measures of sleep and pain into clinical evaluations with this population for further analysis of their utility, followed by a randomized control trial to assess the value of integrating multidisciplinary sleep and pain treatment within the context of obesity treatment.

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