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# Pain Intensity and Pain Interference in Older Adults: Role of Gender, Obesity and high-sensitivity C-reactive protein

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## Abstract

**Background**—Among older adults, pain intensity and pain interference are more common in women than men and associated with obesity and inflammatory markers.

**Objective**—We examined whether the obesity and pain relationship is mediated by the high-sensitivity C-reactive protein (hsCRP), a non-specific marker of systemic inflammation, and whether this relationship differs by sex.

**Methods**—Items from Medical-Outcomes-Study Short-Form 36 were used to measure pain intensity and pain interference in daily life. Ordinal logistic regression was used to assess the cross-sectional association among BMI, hsCRP levels, pain intensity and pain interference using gender-stratified models adjusted for demographic variables.

**Results**—Participants included 667 community-residing adults over age 70, free of dementia enrolled in the Einstein Aging Study (EAS). In women (n=410), pain intensity was associated with obesity (BMI 30 vs. normal, OR=2.29, 95%CI 1.43-3.68) and higher hsCRP (OR=1.28, 95%CI 1.08-1.51). In a model with obesity and hsCRP, both remained significant but the association

between hsCRP and pain intensity was somewhat attenuated. Obesity (OR=3.04, 95%CI 1.81-5.11) and higher hsCRP levels (OR=1.30, 95%CI 1.08-1.56) were also independently associated with greater pain interference in women. After adjustment for pain intensity and BMI, hsCRP was no longer associated with pain interference in women. Greater pain intensity and being overweight or obese continued to be significantly associated with pain interference in women. In men (n=257), obesity and hsCRP were not associated with pain intensity or pain interference.

**Conclusions—**In women, the relationship between obesity and higher levels of pain intensity or interference may be accounted for by factors related to hsCRP.

### Keywords

pain intensity; pain interference; high-sensitive C-reactive protein; Body Mass Index; Gender

## Introduction

About one-fifth of Americans age 65 years or older report a pain-related problem that persist for more than 24 hours in the past 30 days, and 17.5% use a prescription analgesic [1,2]. Pain interferes with activities of daily living in about 60% of older adults who reported any pain in the last month [3]. The prevalence of chronic pain is higher in older than in younger adults, though it is not clear if the prevalence increases with age above age 70 [4]. Pain is commonly measured by separately assessing pain intensity and its functional consequences (pain interference) [5,6]. Pain interference as reflected by measures of activity limitations and health related quality of life increases with age [3]. The relationship between pain intensity and pain interference can be characterized by a threshold effect where low levels of pain intensity are rarely associated with pain interference; however, moderate to severe levels of pain intensity are often associated with pain interference [6,7].

Risk factors for pain in older adults include female gender [8], obesity [9], and biomarkers of inflammation [10]. Obesity is characterized by systemic inflammation and reflected in elevated levels of inflammatory biomarkers, including high-sensitivity C-reactive protein (hsCRP) [11,12]. Elevated levels of systemic inflammation may increase the likelihood of pain by decreasing pain thresholds [13-15]. Therefore, it is important to evaluate the potential pathways that link obesity and systemic inflammation to pain intensity and pain interference.

Compared to men, women are twice as likely to experience chronic pain [4,16,17]. Therefore, we chose to examine the role of obesity and inflammation as risk factors for pain separately in women and men. We hypothesized that the association of obesity, as measured by body mass index (BMI) with pain intensity and pain interference maybe mediated through systemic inflammation. We further hypothesized that the influence of inflammation, as measured by hsCRP, on pain interference is accounted for by its effect on pain intensity.

## Methods

### Subjects

Our sample consisted of participants from the Einstein Aging Study (EAS), a community-based, longitudinal study of adults aged 70 years and older. Participants were systematically recruited from Bronx County, New York using Medicare eligibility information and voter registration lists. EAS exclusionary criteria included being non-English speaking, non-ambulatory, having visual or auditory sensory impairment, or any other condition that would impede assessment. The sample consisted of individuals who completed an annual EAS clinic visit and had data for pain (N = 770), eligibility required data on hsCRP and BMI (N = 709) for the corresponding clinic visit, criteria met by 92% of the initial participants with available data for pain. The general characteristics of 61 participants with missing data on HsCRP or BMI were not different from the final sample. After excluding persons with dementia (N=29), and those with BMI < 18.5 (N = 13), our final sample consisted of N = 667. EAS study design, enrollment procedures, and data collection have been previously described [18,19].

Written informed consent was obtained during all clinic visits in accordance with study protocols approved by the Committee on Clinical Investigation, the Institutional Review Board of the Albert Einstein College of Medicine.

### Clinical Evaluation

Annual clinic visits at the EAS Clinic involved assessments of sociodemographic characteristics (age, sex, race, and education), medical history, current medical status, and a neurological exam. BMI was calculated as weight in kilograms divided by the square of height in meters. Participants were categorized into four groups based on BMI: underweight (BMI < 18.5), normal weight (BMI = 18.5–24.9), overweight (BMI = 25–29.9), and obese (BMI ≥ 30) [4,15,20]. Underweight individuals were excluded from analyses because there were too few individuals in this category. The normal weight category was used as the reference in all models. Waist circumference was measured at the level of the umbilicus.

### Blood Sampling

A phlebotomist drew 20cc whole blood samples from participants. Blood was collected in red top tubes without containing any coagulant and was centrifuged at $3000 \times g$ for 10 minutes at 4°C. Blood samples were processed in batches at the Albert Einstein College of Medicine General Clinical Research Center Core Laboratory using the same CRP Latex reagent on Beckman Coulter AU analyzers according to established procedures. In our study, we collected samples in sterile tubes, chilled, and processed them quickly to preserve inflammatory stability according to established procedures recommended by Beckman Coulter and the current literature [21,22].

We used the serum for analysis of the hsCRP throughout the EAS longitudinal study so that continued use ensures consistency and comparability. HsCRP was measured using the CRP Ultra Wide Range Reagent Kit (Equal Diagnostics, Inc., Exton, PA, USA), a latex-enhanced

turbid metric immunoassay with a sensitivity range from 0.05 mg/dL to 160.0 mg/dL. Inter-assay coefficient of variation was <6%.

## Pain Evaluation

We assessed pain intensity and pain interference using the bodily pain subscale from a self-report, quality of life questionnaire, the Medical Outcomes Study Short Form-36 (MOS SF-36). Reliability and validity for the MOS SF-36 has been previously demonstrated in an elderly population [23,24]. The pain intensity question asked "How much bodily pain have you had during the past 4 weeks?" Scores ranged from 1-6 with 1= "None" and 6 = "Very Severe". Based on this score, participants were categorized into three pain intensity groups: no pain (score = 1), mild pain (score = 2-3), and moderate/severe pain (score = 4-6). The pain interference question asked "During the past 4 weeks, how much did pain interfere with your normal work, including both work outside the home and housework?" Scores ranged from 1-5 with 1 = "Not at all" and 5 = "extremely". Based on this score, participants were categorized into three pain interference groups: no interference (score = 1), mild pain interference (score = 2) and moderate/severe pain interference (scores = 3, 4, and 5). These methods of surveying and categorizing pain outcomes have been used in population-based studies previously [25,26].

## Statistical Analysis

All analyses were adjusted for ethnicity, age, and education, and were conducted in the overall group and stratified by sex in order to determine whether older men and women differ in the pattern of association between obesity, hsCRP levels and pain intensity and interference. Demographic and clinical characteristics were compared between pain intensity (no pain intensity vs mild vs severe) and pain interference (none vs mild vs severe) groups separately using analysis of variance (ANOVA) for continuous variables and Pearson chi-squared test or Fisher's exact test for categorical variables. Non-parametric equivalents were used for variables that violated assumptions of normality. HsCRP distribution was skewed and was log-transformed for all analyses. The dependent measures of pain intensity and pain interference were modeled using ordinal logistic regression. Three models were created for the pain intensity outcome: Model 1 included demographic factors (age, race, and education), and hsCRP. Model 2 included demographic factors and BMI categories. Model 3 included demographic factors, hsCRP, and BMI categories together.

Models 4-10 were created for the pain interference outcome: Model 4 included demographic factors (age, race, and education) and hsCRP. Model 5 included demographic factors and BMI categories. Model 6 included demographic factors hsCRP, and BMI together. Model 7 included demographic factors and pain intensity categories. Model 8 included model 7 plus hsCRP. Model 9 included model 7 plus BMI categories. Model 10 included model 7 plus BMI categories and hsCRP together. Statistical significance was assigned at an alpha level of 0.05.

Both in men and women, models 1-6 were fit using ordinal logistic regression. In models 7-10 the parallel line assumption test was violated, and; therefore, they were fit using a generalized ordinal logistic models that allowed for a relaxation of the parallel line

assumption for violator variables allowing it to be expressed as two separate odd ratios (OR), while maintaining model parsimony and meaning for all other variables SPSS 22 (Chicago, Illinois, USA) and the STATA software, version 12.1 (College Station, Texas) were used for statistical analysis.

## Results

Table 1 shows the demographic and clinical characteristics of the overall sample and stratified by sex and pain intensity status (no pain, mild pain, and moderate/severe pain intensity). Participants were predominately female (61.47%), Caucasian (67.62%), and had a mean age of 79.4 years (SD = 5.49; range 70-100 years). In the overall sample, higher pain intensity levels were associated with higher hsCRP levels, higher BMI, and female sex. Among women, pain intensity levels were associated with higher hsCRP levels and BMI significantly. Conversely, among men, BMI and hsCRP levels did not differ between pain intensity groups. The association between BMI and hsCRP levels occurred in both men (R=0.14, $P$=0.02) and women (R=0.32, $P$<0.001).

Table 2 displays and compares the demographic and clinical characteristics of the overall sample and stratified by sex and pain interference status (no pain, mild pain, and moderate/severe pain interference). Higher pain interference levels in the overall sample were significantly associated with higher hsCRP levels, BMI and the proportion of women. Among women, higher pain interference levels were significantly associated with higher hsCRP levels and BMI. Conversely, BMI and hsCRP levels did not differ between pain interference groups in men. Number of participants in each BMI group is shown in web-table 1. The proportion of men and women within each pain intensity and pain interference category by hsCRP status (panels A and B) and BMI status (panels C and D) is displayed in Web-figure 1. The results for women are presented in Tables 3-5 and the results for men can be found in Web-Tables 2-4.

### Ordinal regression models for pain intensity

**a) Women—**Table 3 shows the results of ordinal logistic regression Models 1-3, which examined factors associated with higher pain intensity in women. Model 1 shows that the inflammatory marker, hsCRP, was significantly associated with pain intensity. The odds of higher pain intensity increased by 28% with each log unit increase of hsCRP (OR=1.28, 95%CI 1.08-1.51, $P$=0.004). Model 2 shows that obese individuals (BMI    30) had 2.29 times greater risk for higher pain intensity compared with the normal BMI group (OR=2.29, 95%CI 1.43-3.68, $P$=0.001); however, overweight subjects (BMI = 25-29.9) were not at increased risk for higher pain intensity compared with the normal BMI group (OR=1.10, 95%CI 0.71-1.71, $P$=0.66). Model 3 showed that when hsCRP and BMI category are combined in the same model, obesity continued to be significantly associated with greater pain intensity (OR=2.02, 95%CI 1.24-3.29, $P$=0.005); however, the association between pain intensity and hsCRP was attenuated and only marginally significant (OR=1.19, 95%CI 1.00-1.42, $P$=0.05).

**b) Men—**Models 1-3 were repeated for men and the results are shown in web-table 2. Obesity and hsCRP were not associated with pain intensity.

### Ordinal regression models for pain interference

**a) Women—**Table 4 shows the results of ordinal logistic regression Models 4-6, which examined the associations among BMI, hsCRP levels and pain interference without adjustment for pain intensity in women. Model 4 shows that higher level of hsCRP was associated with higher levels of pain interference (OR=1.30, 95%CI 1.08-1.55, *P*=0.004). Model 5 shows that higher levels of pain interference are associated with both being overweight (OR=2.15, 95%CI 1.31-3.54, *P*<0.001) and obese (OR=3.04, 95%CI 1.81-5.11, *P<0.001*) versus being normal weight. Model 6 shows that when hsCRP and BMI category are combined in the same model, the association between hsCRP and pain interference was slightly attenuated and only marginally significant (OR=1.21, 95%CI 1.00-1.45, *P*=0.05). The relationship between pain interference and being overweight (OR=2.09, 95%CI 1.27-3.46; *P*=0.001) or obese (OR=2.68, 95%CI 1.57-4.57, p=0.001) versus normal weight was slightly attenuated by the addition of hsCRP to the model but continued to be strongly significant.

**b) Men—**Neither obesity nor hsCRP were associated with pain interference (web-table 3: models 4-6).

### Ordinal regression models for pain interference including pain intensity as variable

**a) Women—**Table 5 (Models 7-10) shows the results of ordinal logistic regression, examining factors associated with category of pain interference taking hsCRP, BMI category and pain intensity into account for women. In model 7, mild and moderate/severe pain intensity was associated with an increased risk of pain interference. Model 8 (adjusting for hsCRP and pain intensity) showed that hsCRP was not associated with pain interference, but pain intensity continued to be significantly associated with pain interference. In model 9 (adjusting for BMI category and pain intensity category), BMI and pain intensity were both strongly associated with pain interference. In Model 10 (adjusting for BMI, pain intensity, and hsCRP), BMI and pain intensity were both significantly associated with pain interference while hsCRP was not significant in any of these models.

**b) Men—**Pain intensity was associated with higher pain interference; however, obesity and hsCRP were not associated with pain interference in men. (Web-table 4: models 7-10).

Finally, we repeated our analysis using waist circumference rather than BMI in men and women. Findings showed virtually identical patterns. In men, waist circumference was not associated with pain intensity or interference. In women, hsCRP and waist circumference were independently associated with pain intensity and pain interference, and the association between hsCRP and pain interference was attenuated after adding waist circumference to both models of pain intensity and interference (results are not shown).

## Discussion and conclusions

This cross-sectional study examined the association of BMI and hsCRP with pain intensity and pain interference. We will first discuss findings in women for pain intensity as the outcome and then for pain interference. We then consider the potential reasons for the lack

of effects in men. In women, after adjusting for demographic variables, hsCRP and obesity were associated with pain intensity and pain interference when examined separately. In a model including both hsCRP and obesity, the independent associations of each with pain intensity remained statistically significant but were modestly attenuated. This attenuation could reflect shared variance between measures of inflammation and BMI. Other studies have also found obesity to be associated with an increased incidence of pain in the elderly [4,9,27-29]. A previous study in the EAS by McCarthy et al. reported that obesity was associated with a twofold increased risk of chronic pain, while, morbid obesity (BMI 35) was associated with fourfold increase in the risk of chronic pain [4]. In a longitudinal study, the overall prevalence of pain in older adults was 32.7% at baseline and this estimate increased significantly with higher quartiles of BMI or waist circumference. Being overweight at baseline was associated with an increased risk of pain in a 6 year follow-up period [27].

Our findings suggest that the influence of obesity on pain intensity maybe mediated through the inflammatory processes indexed by hsCRP. Adipose tissue is an active endocrine organ which secretes substances to regulate several metabolic and physiologic processes [30]. Since the relationship between obesity and pain is attenuated yet remains significant, it is possible that the obesity and pain relationship is mediated through other obesity-related inflammatory markers not measured in this study. Examples include adipocytokines, such as leptin, resistin, and adiponectin [31]. These cytokines are linked to obesity and may contribute to pain and inflammation independent of hcCRP [31,32].

The hsCRP is a useful marker of systemic inflammation that has been linked to many health conditions such as cardiovascular disease, myocardial infarction, diabetes, osteoporosis [33]. While hsCRP levels of more than 10 mg/L reflect clinically significant inflammation, subclinical levels of it (3 – 10 mg/L) suggest an elevated risk for the development of disease [34]. High hsCRP levels have been associated with number of pain conditions such as fibromyalgia and rheumatoid arthritis [33]. A pain study in females that used cold pain sensitivity ratings showed the direct association between CRP and pain threshold and tolerance after adjusting for age, BMI, time to reach pain threshold or tolerance, and clinical pain status [35].

In addition we showed that both higher hsCRP levels, and being overweight or obese were associated with greater pain interference in women, in separate models. Similar to our finding with pain intensity, the relationships between pain interference with both BMI and hsCRP remained statistically significant but were modestly attenuated when hsCRP and BMI were included in the same model. The attenuation of the relationship between BMI and pain interference by the addition of hsCRP to the model suggests that the association between BMI and pain interference may be mediated, at least in part, by hsCRP. To date, there are limited studies that examine pain interference in older adults [26,36]. A longitudinal study in comparison with the normal weighted, being overweight or obese was associated with an increased risk of future development of pain interference. This association was stronger in obese individuals compared to overweight individuals, suggesting a dose-dependent effect of BMI on pain interference [28].

In our study, we modelled pain interference as the outcome adding pain intensity to the measures of demographic factors, obesity and inflammation discussed above. As expected, pain intensity is strongly associated with pain interference in both men and women. Among women, when pain intensity is included in the model, hsCRP is not significantly associated with pain interference; however, obesity remains significantly associated. To our knowledge, prior studies have not assessed the influence of inflammatory markers on pain interference in older adults.

The precise mechanisms linking obesity, inflammation, pain intensity and pain interference warrant further exploration. The cross-sectional design of this study precludes conclusions regarding causality or directionality of the relationships among obesity, hsCRP and pain. Obesity is a pro-inflammatory state characterized by the release of inflammatory compounds including hsCRP and insulin resistance-inducing substances from visceral adipose tissue [29,37,38]. Adipose tissue also releases factors which stimulate CRP production in the liver [20]. This gives biological plausibility to the idea that obesity results in hsCRP elevation, which, in turn, leads to higher rate of pain.

We cannot rule out the possibility of reverse causality, whereby, pain leads to reduced physical activity and/or overeating and, in turn, increased BMI [29,39]. It is also possible for pain and obesity to have a bidirectional relationship, whereby, obesity leads to inflammation and pain and pain decreases activity leading to obesity. For example, obesity is a major risk factor for osteoarthritis, a highly prevalent pain disorder in the elderly [29]. Obesity causes joint damage through different mechanisms such as increased cytokines, the co-existence of obesity with metabolic impairments, and mechanical loading [31]. On the other hand, osteoarthritis limits mobility, which can lead to increase in weight [40]. This could be suggestive of a bidirectional relationship leading to increased inflammation [31,41,42].

The associations among BMI, hsCRP and pain outcomes were found only in women, a finding consistent with prior demonstrations of sex difference [43]. In comparison with men, women report more frequent pain, higher pain intensity, more pain interference, and longer durations of pain [44]. Females generally report lower pain thresholds and tolerance than males. In a study of older Canadian adults, among participants with pain, women were more likely to experience interferences with physical and psychological functioning than men [36]. A longitudinal study in adults aged greater than 50 years found that the onset of pain interference increases with age and has a strong gender difference, with women reporting more pain interference [26]. This could reflect sex difference in response to pain, in the social rules governing pain reporting, or in biological mechanisms underlying pain [44].

We found that pain intensity and interference are related to obesity and inflammation in women and not men. There are a number of possible explanations for this sex difference. Women have more adipose tissue than men, and a higher percent body fat, at a given BMI, [45]. Additionally, association between adiposity and low-grade systemic inflammation, as indexed by CRP level, is higher in women in comparison with men [46]. In our sample, the positive correlation between hsCRP and BMI was significant in both men and women but higher in women (R = 0.32) compared to men (R = 0.14). At a given BMI, women may have more adipose tissue than men. Alternatively, adipose tissue in women may produce more

inflammatory cytokines than adipose tissue in men. In either case, greater levels of CRP in women may lead to more pain. Sex hormones offer another potential explanation. Older men have higher estradiol levels compared with age-matched women [47]. As estrogens have an inhibitory effect on inflammatory cytokines [48], higher estradiol levels in older men may protect against the pro-inflammatory influence of obesity.

Testosterone, similar to estrogen, has anti-inflammatory properties [49]. It reduces serum levels of the pro-inflammatory and increases levels of the anti-inflammatory cytokines [50,51]. Although testosterone levels decrease in men with aging, it remains the predominant sex hormone in men throughout life [49]. Therefore, older men have higher levels of estrogen and testosterone, and possibly more anti-inflammatory properties compared to older women. Future investigations should examine the effect of hormone levels on inflammation, pain intensity and interference.

This study has strengths and limitations. Strengths include the EAS population, which consists of relatively healthy, community-dwelling individuals who were systematically recruited from our Bronx community. We measured pain intensity and interference as well as hsCRP. The cross-sectional design precludes the determination of temporal sequence. Longitudinal studies examining the association between obesity and pain using inflammatory markers are needed. Because of the budgetary limitations, we examined a single inflammatory biomarker, hsCRP. Levels of other inflammatory markers that might contribute to the obesity-pain relationship were not assessed. Therefore, our results are limited to CRP, a non-specific marker of systemic inflammation, and cannot be generalized to all types of inflammation [11,12,15].

Serum samples may contain inflammatory cytokines secreted from leukocytes, mainly during the clotting process [21,52]. While cytokines regulate the production of hsCRP, this only takes place in the tissues mainly liver [21,53]. Therefore, we are not sure if the release of cytokines during the serum production can impact the hsCRP levels in the blood tube. Based on some internal data analysis, no significant statistical difference between CRP level in serum and plasma was reported [22].

In summary, we found that high-sensitivity C-reactive protein (hsCRP), a non-specific marker of systemic inflammation, plays a critical role in the relationship between obesity and pain; however this role appears to be specific to older women and not men. Among women, the relationship among obesity, hsCRP levels and pain may reflect a complex interaction of fat mass, joint inflammation, mild systemic inflammation, and pain.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

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**Table 1**

Demographic and medical characteristics and comparison of participants with no pain, mild pain, and moderate/severe pain intensity in all, men, and women.

| | Pain Intensity | | | | | | | | | | | | | | |
| | All participants (N=667) | | | | Men (N=257) | | | | Woman (N=410) | | | |
| Variables | No Pain | Mild Pain | Moderate/Severe Pain | P | No Pain | Mild Pain | Moderate/Severe Pain | P | No Pain | Mild Pain | Moderate/Severe Pain | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| N, (%) | 206 (30.9) | 232 (34.8) | 229 (34.3) | | 101 (39.3) | 92 (35.8) | 64 (24.9) | | 105 (25.6) | 140 (34.1) | 165 (40.2) | |
| Age, mean Years (SD) | 80.0 (5.6) | 79.1 (5.5) | 78.9 (5.2) | 0.09 | 80.6 (6.0) | 79.9 (5.4) | 79.3 (5.1) | 0.32 | 79.5 (5.1) | 78.5 (5.4) | 78.7 (5.2) | 0.26 |
| Sex, Female (%) | 105 (51.0) | 140 (60.3) | 165 (72.1) | **<0.01** | - | - | - | 0.12 | - | - | - | - |
| Race: | | | | **<0.01** | | | | 0.12 | | | | **0.02** |
| -African American, N (%) | 57 (31.8) | 48 (26.8) | 74 (41.3) | | 23 (53.4) | 9 (20.9) | 11 (25.5) | | 34 (25.0) | 39 (28.6) | 63 (46.3) | |
| -Caucasian, N (%) | 143 (31.7) | 161 (35.7) | 147 (32.5) | | 75 (37.1) | 76 (37.6) | 51 (25.2) | | 65 (27.3) | 85 (34.1) | 96 (38.5) | |
| -Others, N (%) | 6 (16.2) | 23 (62.1) | 8 (21.6) | | 3 (25.0) | 7 (58.3) | 2 (16.6) | | 3 (12.0) | 16 (64.0) | 6 (24.0) | |
| Education, mean years (SD) | 14.2 (3.4) | 14.2 (3.6) | 13.9 (3.3) | 0.51 | 14.0 (3.7) | 14.7 (3.8) | 14.3 (3.3) | 0.50 | 14.3 (3.0) | 13.8 (3.5) | 13.7 (3.3) | 0.32 |
| hsCRP, mean level (SD) | 3.20 (4.39) | 3.24 (3.97) | 4.15 (5.21) | **0.02** | 3.40 (4.06) | 3.31 (4.55) | 4.13 (6.10) | 0.83 | 3.01 (4.70) | 3.19 (3.55) | 4.17 (4.84) | **<0.01** |
| Log_HsCRP, mean level (SD) | 0.53 (1.12) | 0.60 (1.10) | 0.81 (1.15) | **0.02** | 0.61 (1.12) | 0.55 (1.17) | 1.23 (0.15) | 0.79 | 0.46 (1.13) | 0.62 (1.06) | 0.87 (1.11) | **<0.01** |
| BMI, mean (SD) | 26.96 (4.61) | 27.29 (4.26) | 28.75 (5.48) | **<0.01** | 27.69 (4.84) | 27.23 (3.53) | 27.46 (4.07) | 0.69 | 26.25 (4.28) | 27.34 (4.69) | 29.25 (5.87) | **<0.01** |
| WHR, mean (SD) | 0.70 (0.10) | 0.70 (0.10) | 0.70 (0.10) | 0.97 | 0.76 (0.08) | 0.76 (0.09) | 0.78 (0.10) | 0.40 | 0.65 (0.08) | 0.66 (.08) | 0.67 (0.09) | 0.10 |

Abbreviations: WHR=Waist-Hip Ratio

**Table 2**

Demographic and medical characteristics and comparison of participants with no pain, mild pain, and moderate/severe pain interference in all, men, and women.

| Variables | Pain Interference | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | All participants (N=667) | | | | Men (N=257) | | | | Woman (N=410) | | | |
| | No Pain Interference | Mild Pain Interference | Moderate/Severe Pain Interference | P | No Pain Interference | Mild Pain Interference | Moderate/Severe Pain Interference | P | No Pain Interference | Mild Pain Interference | Moderate/Severe Pain Interference | P |
| N, (%) | 423 (63.4) | 128 (19.2) | 116 (17.4) | | 179 (69.6) | 43 (16.7) | 35 (13.6) | | 244 (59.5) | 85 (20.7) | 81 (19.7) | |
| Age, mean Years (SD) | 79.7 (5.5) | 78.4 (5.5) | 78.9 (4.9) | **0.05** | 80.4 (5.7) | 79.0 (5.4) | 79.0 (5.3) | 0.30 | 79.2 (5.4) | 78.1 (5.5) | 78.8 (4.8) | 0.21 |
| Sex, Female (%) | 244 (57.7) | 85 (66.4) | 81 (69.8) | **0.02** | - | - | - | - | - | - | - | - |
| Race: | | | | 0.18 | | | | 0.92 | | | | 0.13 |
| -African American, N (%) | 100 (55.8) | 40 (22.3) | 39 (21.7) | | 31 (72.0) | 7 (16.2) | 5 (11.6) | | 69 (50.7) | 33 (24.2) | 34 (25.0) | |
| -Caucasian, N (%) | 299 (66.3) | 82 (18.1) | 70 (15.5) | | 141 (69.8) | 33 (16.3) | 28 (13.8) | | 158 (3.4) | 49 (19.6) | 42 (16.8) | |
| -Others, N (%) | 24 (64.8) | 6 (16.2) | 7 (18.9) | | 7 (58.3) | 3 (25.0) | 2 (16.6) | | 17 (68.0) | 3 (12.0) | 5 (20.0) | |
| Education, mean years (SD) | 14.2 (3.4) | 13.8 (3.6) | 13.9 (3.4) | 0.58 | 14.2 (3.7) | 14.9 (3.1) | 14.9 (3.1) | 0.64 | 14.2 (3.1) | 13.3 (3.7) | 13.7 (3.3) | 0.18 |
| hsCRP, mean level (SD) | 3.41 (4.70) | 3.82 (4.36) | 3.71 (4.34) | 0.06 | 3.76 (5.29) | 3.02 (3.35) | 3.02 (3.35) | 0.90 | 3.16 (4.21) | 4.23 (4.76) | 3.95 (4.63) | **<0.01** |
| Log_HsCRP, mean level (SD) | 0.57 (1.16) | 0.81 (1.05) | 0.77 (1.07) | **0.05** | 0.63 (1.2) | 0.57 (1.04) | 0.55 (1.14) | 0.92 | 0.53 (1.14) | 0.94 (1.04) | 0.86 (1.04) | **<0.01** |
| BMI, mean (SD) | 27.10 (4.64) | 28.70 (5.14) | 28.73 (5.06) | **<0.01** | 27.56 (4.50) | 27.88 (3.60) | 27.88 (3.60) | 0.27 | 26.76 (4.72) | 29.12 (5.74) | 29.70 (5.42) | **<0.01** |
| WHR, mean (SD) | 0.70 (0.10) | 0.72 (0.10) | 0.71 (0.09) | 0.17 | 0.76 (0.09) | 0.78 (0.09) | 0.78 (0.09) | 0.68 | 0.65 (0.08) | 0.69 (0.09) | 0.69 (0.09) | **<0.01** |

Abbreviations: WHR=Waist-Hip Ratio

**Table 3**

Association of pain intensity level (none vs. mild vs. moderate-severe) with hsCRP and obesity in women: Models of ordinal logistic regression adjusting for, ethnicity, age, and education.

| | Pain Intensity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1 | | | Model 2 | | | Model 3 | | |
| Variables | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Ethnicity [†] | 1.15 | 0.79-1.68 | 0.47 | 1.04 | 0.70-1.52 | 0.86 | 1.03 | 0.70-1.52 | 0.87 |
| Age | 0.99 | 0.96-1.03 | 0.40 | 0.99 | 0.96-1.03 | 0.67 | 0.99 | 0.96-1.03 | 0.72 |
| Education (Years) | 0.97 | 0.92-1.02 | 0.22 | 0.97 | 0.92-1.02 | 0.26 | 0.97 | 0.92-1.03 | 0.30 |
| log_CRP Level | 1.28 | 1.08-1.51 | **<0.01** | ---- | ------ | ----- | 1.19 | 1.00-1.42 | **0.05** |
| BMI: | ---- | ------ | ----- | | | | | | |
| Normal weight (18.5-24.9) | ---- | ------ | ----- | Reference | | | Reference | | |
| Overweight (25-29.9) | ---- | ------ | ----- | 1.10 | 0.71-1.71 | 0.66 | 1.06 | 0.68-1.65 | 0.79 |
| Obese and Morbid Obese ( 30) | ---- | ------ | ----- | 2.29 | 1.43-3.68 | **<0.01** | 2.02 | 1.24-3.29 | **<0.01** |

[†] Ethnicity is considered as all non-white participants versus white participants.

**Table 4**

Association of pain interference level (none *vs.* mild *vs.* moderate-severe) with hsCRP and obesity in women: Models of ordinal logistic regression adjusting for ethnicity, age, and education.

| | Pain Interference | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Model 4 | | | Model 5 | | | Model 6 | | |
| Variables | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Ethnicity † | 1.42 | 0.95-2.12 | 0.09 | 1.28 | 0.85-1.92 | 0.24 | 1.28 | 0.85-1.93 | 0.23 |
| Age | 0.98 | 0.95-1.02 | 0.41 | 0.99 | 0.95-1.03 | 0.71 | 0.99 | 0.96-1.03 | 0.79 |
| Education (Years) | 0.96 | 0.91-1.02 | 0.17 | 0.96 | 0.90-1.02 | 0.17 | 0.96 | 0.91-1.02 | 0.21 |
| hsCRP Level | 1.30 | 1.08-1.56 | **<0.01** | ----- | ----- | ----- | 1.21 | 1.00-1.45 | **0.05** |
| BMI: | | | | | | | | | |
| Normal weight (18.5-24.9) | ---- | ----- | ----- | | Reference | | | Reference | |
| Overweight (25-29.9) | ---- | ----- | ----- | 2.15 | 1.31-3.54 | **<0.01** | 2.09 | 1.27-3.46 | **<0.01** |
| Obese and Morbid Obese ( 30) | ---- | ----- | ----- | 3.04 | 1.81-5.11 | **<0.01** | 2.68 | 1.57-4.57 | **<0.01** |

†Ethnicity is considered as all non-white participants versus white participants.

**Table 5**

The association of pain interference level (none *vs.* mild *vs.* moderate-severe) with obesity, Log_CRP level, and pain intensity in women: Models of ordinal logistic regression adjusting for ethnicity, age, and education.

| | | | | | | | | Pain Interference | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 7 | | | Model 8 | | | Model 9 | | | Model 10 | | |
| Variables | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Ethnicity [†] | 1.51 | 0.96-2.38 | 0.08 | 1.50 | 0.95-2.36 | 0.08 | 1.39 | 0.87-2.21 | 0.16 | 1.39 | 0.88-2.23 | 0.16 |
| Age | 0.99 | 0.95-1.03 | 0.52 | 0.99 | 0.95-1.04 | 0.68 | 1.00 | 0.95-1.04 | 0.82 | 1.00 | 0.95-1.04 | 0.89 |
| Education (Years) | 0.97 | 0.91-1.03 | 0.39 | 0.97 | 0.91-1.04 | 0.44 | 0.97 | 0.91-1.04 | 0.38 | 0.97 | 0.91-1.04 | 0.42 |
| hsCRP Level | ---- | ------ | ---- | 1.17 | 0.95-1.43 | 0.14 | ------ | ------ | ------ | 1.12 | 0.90-1.39 | 0.30 |
| BMI: | | | | | | | | | | | | |
| Normal weight (18.5-24.9) | ------ | ------ | ------ | ------ | ------ | ------ | Reference | | | Reference | | |
| Overweight (25-29.9) | ------ | ------ | ------ | ------ | ------ | ------ | 2.54 | 1.43-4.51 | <0.01 | 2.51 | 1.41-4.46 | <0.01 |
| Obese and Morbid-Obese ( 30) | ------- | ------ | ------ | ------ | ------ | ------ | 2.29 | 1.28-4.12 | <0.01 | 2.13 | 1.17-3.89 | <0.01 |
| Pain Intensity-Mild | 16.29 | 4.88-54.35 | <0.01 | 16.11 | 4.83-53.81 | <0.01 | 17.06 | 5.07-57.42 | <0.01 | 17.07 | 5.06-57.50 | <0.01 |
| Pain Intensity-Severe | 82.45 | 24.82-273.90 | <0.01 | 79.01 | 23.75-262.83 | <0.01 | 83.96 | 25.01-281.83 | <0.01 | 82.45 | 24.54-276.98 | <0.01 |

[†] Ethnicity is considered as all non-white participants versus white participants.