The Association Among Overweight, Obesity, and Low Back Pain in U.S. Adults: A Cross-Sectional Study of the 2015 National Health Interview Survey

Trent Peng, MS, DC,[a] Adriana Pérez, MS, PhD,[b] and Kelley Pettee Gabriel, MS, PhD[a,c]

Abstract

Objective: The purpose of this study was to explore the association between obesity (via body mass index [BMI]) and presence of low back pain (LBP) in a representative sample of US adults, aged ≥18 years.
Methods: This cross-sectional study used data from 32 060 respondents to the 2015 National Health Interview Survey. Body mass index (kg/m^2) was calculated using reported height and weight and expressed as normal weight (<25 kg/m^2), overweight (25 to <30 kg/m^2), or obese (≥30 kg/m^2); 3-month prevalence of reported LBP was the targeted outcome. Weighted univariate and multivariable logistic regression (adjusting for age, sex, race/ethnicity, education, and leisure-time physical activity) were performed. Interaction by sex and race/ethnicity was also explored.
Results: Findings suggest a statistically significant association between BMI categories and LBP. The adjusted odds ratios (95% confidence interval) of LBP in overweight and obese participants were higher than those in normal weight participants: 1.21 (1.11-1.32) and 1.55 (1.44-1.67), respectively. Both sex and race/ethnicity statistically significantly modified the association between BMI and LBP. Compared with normal weight white men (reference), odds ratios (95% confidence interval) of LBP were higher among obese white men, obese white women, and obese nonwhite women (1.28 [1.10, 1.48], 1.58 [1.36, 1.84], and 1.36 [1.16, 1.60], respectively), and lower in overweight, nonwhite men, and normal weight nonwhite men and women (0.80 [0.68, 0.94], 0.62 [0.51, 0.76], and 0.73 [0.61, 0.87], respectively).
Conclusion: Overweight and obesity were associated with increased odds of LBP. However, the measures of associations varied in magnitude and direction by race and sex groups. (J Manipulative Physiol Ther 2018;41:294-303)
Key Indexing Terms: *Low Back Pain; Obesity; Overweight; Body Mass Index*

Introduction

Low back pain (LBP) is considered one of the most common musculoskeletal problems in the general population.[1] The worldwide lifetime prevalence of LBP in 2012 was 39.9% ± 24.3%, and the 1-month prevalence of LBP was 23.2% ± 2.9%.[2] Although LBP is rarely life threatening, it is a physically disabling condition. More specifically, based on a 2010 study that investigated the global burden of 291 medical conditions, LBP was ranked sixth overall in disability-adjusted life years, a measure used to determine loss of total healthy years from disease.[3] Because of the high prevalence and severity of LBP, direct medical costs for LBP treatment ranged from US$12.2 and US$90 billion annually, making it a significant public health problem.[4]

The prevalence of LBP has been shown to vary by demographic characteristics, based on epidemiologic studies. In US adults, the prevalence of LBP generally increases with increasing age categories, until ages 60 to 65 years, when prevalence estimates decline.[5] The prevalence of LBP is higher in women than men, based on a systematic review of 165 studies from 56 countries.[2] Differences in the prevalence of LBP was also identified across racial and ethnic groups. More specifically, a previous study by Deyo et al[6] reported the highest prevalence of LBP in American

[a] Department of Epidemiology, Human Genetics and Environmental Sciences, School of Public Health, University of Texas Health Science Center, Austin Regional Campus, Austin, Texas.
[b] Department of Biostatistics, School of Public Health, University of Texas Health Science Center, Austin Regional Campus, Austin, Texas.
[c] Department of Women's Health, The University of Texas at Austin, Dell Medical School, Austin, Texas.
Corresponding author: Trent Peng, MS, DC, 1616 Guadalupe Street, Suite 6.300, Austin, TX 78701. Tel.: +1 512 743 9616. (e-mail: *Trent.peng@uth.tmc.edu*).
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Indians and Alaskan Native (AIAN), followed by whites, Hispanics, blacks, and Asians. Sociodemographic factors, including lower educational attainment and income, have also been reported to be positively associated with LBP.[7,8] This may be due to the fact that less educated and affluent individuals are more likely to reside in rural areas and more often participate in activities that require heavy manual labor.[9] Occupational tasks requiring lifting and material handling, static work postures, and use of vibrating equipment have previously been reported to be associated with LBP.[10-12] In a study by Heneweer et al,[13] the authors reported an increased odds of LBP among those who are inactive and excessively active.

Obesity is also a highly prevalent condition. Based on data from the 2011-2012 National Health and Nutrition Examination Survey, the age-adjusted prevalence of overweight (body mass index [BMI] $\geq$25 kg/m^2) and obese (BMI $\geq$30 kg/m^2) US adults (aged $\geq$20 years) was 68.5% (95% confidence interval [CI] 65.2%-71.6%) and 34.9% (95% CI 32.0%-37.9%), respectively.[14] In fact, the prevalence of individuals classified as overweight or obese in the US has been steadily climbing since 1976.[15] Factors that are associated with LBP are also associated with obesity, including age, sex, race/ethnicity, and physical activity.[15] However, subgroups at highest risk may vary between these conditions. For example, although the prevalence of LBP is highest in women, the prevalence of obesity is higher in men.

Obesity has long been considered a risk factor for LBP as a result of underlying biological plausibility. Anatomically, weight gain causes increased mechanical loading on the lumbar spine, which introduces a cascade of changes, including a reduction in disc hydration, altered biomechanics, and deleterious stress distribution of tissues, eventually leading to disc degeneration and LBP.[16,17] Therefore, based on these biological mechanisms, health care professionals tend to associate obesity with severity of low back pain, with additional expectations of a poorer prognosis and longer recovery time among these individuals.[18] However, unlike occupational exposures that may not be amenable to change, obesity is considered a modifiable risk factor.

Despite the underlying biological plausibility, epidemiologic evidence linking obesity and LBP has been conflicting. For instance, a systematic review revealed that only 32% of the 65 studies reviewed identified a positive association between obesity and LBP, whereas the rest reported statistically null associations.[19] Based on this comprehensive review, the Leboeuf-Yde et al[19] concluded that there was insufficient evidence to establish a causal link between body weight and LBP. However, a later meta-analysis identified a positive association between obesity and LBP when data from individual studies (including more recent investigations) were pooled.[20] Specifically, the pooled odds of reported LBP in the past 12 months was 1.23 times higher in overweight (odds ratio [OR] = 1.23, 95% CI 1.15-1.31) and 1.35 times higher in the obese (OR = 1.35, 95% CI 1.12-1.56) participants compared with normal weight participants. This provides some evidence of a causal relationship. However, like the studies included in the systematic review by Leboeuf-Yde et al,[19] results from more recent studies (ie, in the past 5 years) have been mixed, with some studies reporting a statistically significant positive association[21-24] and others reporting a statistically null association.[25-27] There is also inconsistency among nations; in a 9-country study, the association between overweight/obesity and back pain was positive for some countries and null for others.[28] Beyond the meta-analysis by Shiri et al,[20] this general lack of consistency across studies may be due to a variety of factors, including inadequate sample size, use of targeted population subgroups (eg, occupational cohorts), varied measures or classifications of obesity, and potential for residual confounding. Furthermore, relatively fewer obesity-LBP studies were conducted in the United States,[22,24,29-31] which limits the external validity of most study findings. Given these limitations, further studies in large and diverse populations are needed to clarify the relationship between obesity and LBP.

Therefore, the primary objective of this secondary data analysis was to examine the association between obesity (via BMI) and LBP in a diverse sample of adults enrolled as participants in the 2015 National Health Interview Survey (NHIS). The richness of the NHIS dataset also provides the unique opportunity to account for key covariates biologically relevant to this exposure-outcome relationship. This, in turn, reduces the potential for residual confounding resulting in a more precise measure of association. The underlying hypothesis being tested is that, compared with normal weight, overweight and obesity is associated with a higher risk of reported LBP prevalence among US adults, after adjustment for key covariates.

Methods

Study Design and Participants

The National Health Interview Survey (NHIS) is a cross-sectional household interview survey conducted by the National Health Statistics Office of the Center for Disease Control and Prevention yearly, and most data contained are publicly available. Details about the sampling and data collection procedures are available online.[32] Briefly, the NHIS samples from the noninstitutionalized civilian population of the United States using a multistage probability sampling design and oversamples Hispanics and non-Hispanic blacks to provide a representative sample of US households. Study locations include 428 of the approximately 1900 primary sampling units throughout the United States, which consist of counties, towns, and metropolitan statistical areas. Trained US Census Bureau personnel conducted in-person interviews at each selected household, using the computer-assisted personal interview technique. The Family, Person, and Sample Adult core sections of the 2015 NHIS survey were used for this secondary data analysis, which includes sociodemographic variables such as age, sex, race/ethnicity, income and level of education, and health risk factors and behaviors. In the 2015 NHIS cycle, a total of 33 672 adults (age ≥18 years old) completed the interview.

This study was a secondary data analysis using the publicly available NHIS database, and all personal information were deidentified. The present analyses were reviewed by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center (Houston, Texas) and declared exempt from oversight (Exempt #HSC-SPH-15-0212).

Exposure: Obesity

Body mass index is the ratio of weight (in kilograms) over height squared (in meters) and was used in the present study as an estimate of obesity. To obtain height and weight measures, NHIS interviewers asked the following questions to NHIS respondents*: "How tall are you without shoes?" and "How much do you weigh without shoes?"* Participants could answer in either US customary (ie, pounds, ounce, feet, inches) or metric (ie, kilograms, meters, centimeters) units, with all reported information being standardized to kilograms and meters. Body mass index was calculated in NHIS for participants that reported both height and weight. To address the study objectives, continuous BMI measures were classified into 4 categories (underweight [BMI <18.5 kg/m^2], normal weight [18.5 kg/m^2 ≤ BMI < 25 kg/m^2], overweight [25.0 kg/m^2 ≤ BMI < 30 kg/m^2), and obese [BMI ≥30 kg/m^2]). Because of a low proportion of participants classified as "underweight" (ie, 1.9%), the underweight and normal weight categories were combined and expressed as normal weight in the analytic phase.

Outcome: LBP

In the present analysis, LBP was defined as reporting yes to the following question: *"During the past 3 months, did you have low back pain?"* Those who responded "no" served as the comparison group. Responses other than "yes" or "no" ("refused," "not ascertained," "don't know") were recorded as missing data.

Potential Covariates

The potential covariates included in this study were based on previous literature linking these variables to exposure and/or outcome and included, age, sex, race/ethnicity, educational attainment, and leisure-time physical activity.[2,6,7,33-35] Income and other psychosocial variables were considered as potential covariates; however, they were not included because of the high proportion of missing data (income) or lack of adequate information (psychosocial variables) that are collected as part of NHIS. In the 2015 NHIS, information on age, sex, and educational attainment were collected via standardized items. Age (in years) was categorized into 3 groups for this analysis: 18 to 39, 40 to 59, and ≥60 years. Educational attainment was collected via 9 response options but collapsed for analysis in 2 groups: less than associate degree or associate degree and higher. Race/ethnicity and Hispanic origin information were collected by a series of questions. First, Hispanic origin was determined by asking, *"Do you consider yourself Hispanic/Latino (yes/no)?"* If yes, the participant was classified as Hispanic/Latino. If no, a follow-up question was asked to determine race: *"What race do you consider yourself to be?"* The options for race included "white only," "black/African American only," "American Indian and Alaskan Native (AIAN)," "Asian only," "data not releasable," and "multiple races." If a participant identified with the multiple races response option, she or he was asked to select 1 race that best represents his or her race using the follow-up question, "*Which one of these groups, that is (read groups selected), would you say BEST represent your race?"* Because of the small sample size per race/ethnic strata, Asians, AIANs, and participants reporting multiple races were classified in the present analysis as "other."

To ascertain leisure-time physical activity (LTPA), participants were asked to report the frequency and duration of prior activity within broad physical activity intensity categories: light, moderate, and vigorous. For each intensity category, participants could report frequency and duration of LTPA using any units, including times per day, per week, per month, or per year. However, responses were recoded to the standardized unit of minutes per week. Total LTPA minutes per week were calculated by multiplying the total weekly minutes of reported vigorous activity by 2, which was then added to the total number of minutes of reported moderate-intensity physical activity per week. Based on documentation provided by NHIS, continuous LTPA (in minutes per week) was classified into categories reflecting the 2008 US Physical Activity Guidelines,[36] including inactive (0 min/wk), insufficient activity (0-149 min/wk), and sufficient activity (≥150 min/wk).

Statistical Analysis

As mentioned previously, the NHIS employs a multistage, complex sampling design that involves stratification, clustering, and oversampling of specific populations in the United States. Sampling weights were provided by the NHIS and applied before analysis to ensure accurate and valid estimation of the US civilian and noninstitutionalized population. To address the primary study goal, a complete case analysis was used. More specifically, participants with any missing, unknown, or unavailable data or responses involving "refused," "not ascertained," or "don't know" in any of the variables or covariates studied were considered "missing data" and excluded from the analysis. Differences in the demographic characteristics between participants with complete data and those excluded from the study were analyzed to identify potential selection bias.

STATA software, Version 13.0 (StataCorp LLC, College Station, Texas) was used for the statistical analyses. Weighted logistic regression models were used to account for the sample weights. A 2-sided type I error level of 0.05 was used and additional adjustment for multiple comparisons was not conducted.

Using the analytic sample, weighted frequencies and percentages were estimated for categorical variables; weighted mean and standard error of the mean were reported for continuous variables. Given the large sample size, continuous variables were assumed to be normally distributed based on the central limit theorem. Univariate, weighted logistic regression was performed on each variable (ie, primary exposure and covariates) against LBP, individually, to compute a crude odds ratio (with 95% confidence intervals). For multivariable analyses, weighted logistic regression was used to explore the association between BMI and LBP after adjusting for age, sex, race/ethnicity, educational attainment, and LTPA. For this multivariable analyses, dummy variables were created for age (3 categories), race/ethnicity (4 categories), BMI (3 categories), and leisure-time physical activity (3 categories). The normal weight category served as the reference group.

The role of sex (2 categories) and race/ethnicity (collapsed into 2 categories, whites and others, as a result of sample size considerations) as potential effect modifiers in the association between BMI and LBP was explored via a 3-way interaction analysis. For this analysis, 11 dummy variables representing 12 combinations of BMI, sex, and race/ethnicity were created with normal-weight white men serving as the reference group. Goodness-of-fit tests were also conducted for all univariate and multivariable models (including multivariable models testing for possible interaction by sex and race/ethnicity groups).[37]

Results

Participants

We used a complete case analysis for this study, and 1612 of the 33 672 adult participants were excluded as a result of missing data. These exclusions resulted in a final analytic sample of 32 060 (or 95.2% of 33 672) participants (Fig 1).

Differences in demographic characteristics (age and sex) were examined between participants with complete and missing data. Those with missing data (ie, excluded from the analytic sample) were older compared with those with complete data (aged 48.8 vs 47.0 years), and the difference was statistically significant. There was a statistically significantly higher proportion of women excluded vs those retained in the analytic dataset (70.4% vs 50.8%, respectively).

Characteristics of the Analytic Sample

Weighted estimates of the analytic sample characteristics are presented in Table 1. Briefly, the mean age of the analytic sample was 47.0 (standard error [SE]: 0.2) years and were predominantly female (50.8%), white (64.9%), with at least an associate college degree (56.7%). Approximately half of the analytic sample reported sufficient LTPA (49.3%). With regard to the primary exposure variable, only 36.2% of participants were considered normal weight (includes underweight), whereas the majority were either overweight or obese (63.8%). To provide additional context, the mean BMI was 27.9 (SE: 0.1) kg/m^2 for this particular sample. The 3-month prevalence of reported LBP was 30.0%.

Univariate Analysis: Unadjusted Association Between BMI and LBP

Table 2 shows the unadjusted associations between the primary exposure and covariates with LBP. With regard to the primary exposure, when compared with the normal-weight group (BMI <25 kg/m^2), the crude odds for reported LBP within the past 3 months was 1.27 (95% CI 1.16-1.38) and 1.72 (95% CI 1.60-1.85) times higher in overweight and obese participants, respectively. Compared with younger participants (aged 18-39), odds of LBP was higher for both older age groups (40-59 and ≥60 years age groups). Further, when compared with men, the odds of LBP were statistically significantly higher in women. The odds of LBP were statistically significantly lower in blacks, Hispanics, and other race/ethnicity (ie, Asians, AIANs, and multiple races) compared with whites. Participants with at least an associate degree had statistically significantly lower odds of LBP compared with the reference group (less than an associate degree). Participants classified as inactive or insufficiently active during their leisure time had a higher odds of LBP compared with those who were sufficiently active (Table 2).

Multivariable Analysis: Adjusted Association Between BMI and LBP

Table 2 also presents the adjusted odds ratios of LBP for the primary exposure variable (BMI categories) and selected covariates. Compared with normal-weight participants, the adjusted odds were higher for both the overweight and obese categories, similar to the crude associations (Table 2). The adjusted odds ratios between the included covariates and LBP were also similar to what was found in the univariate analysis.

Multivariable Analysis: Sex by Race/Ethnic Interaction

A statistically significant 3-way interaction by sex and race/ethnic groups was identified when further examining the adjusted association between BMI categories and LBP (interaction term: P <.01). As shown in Table 3, compared with normal-weight white males (reference group), the odds

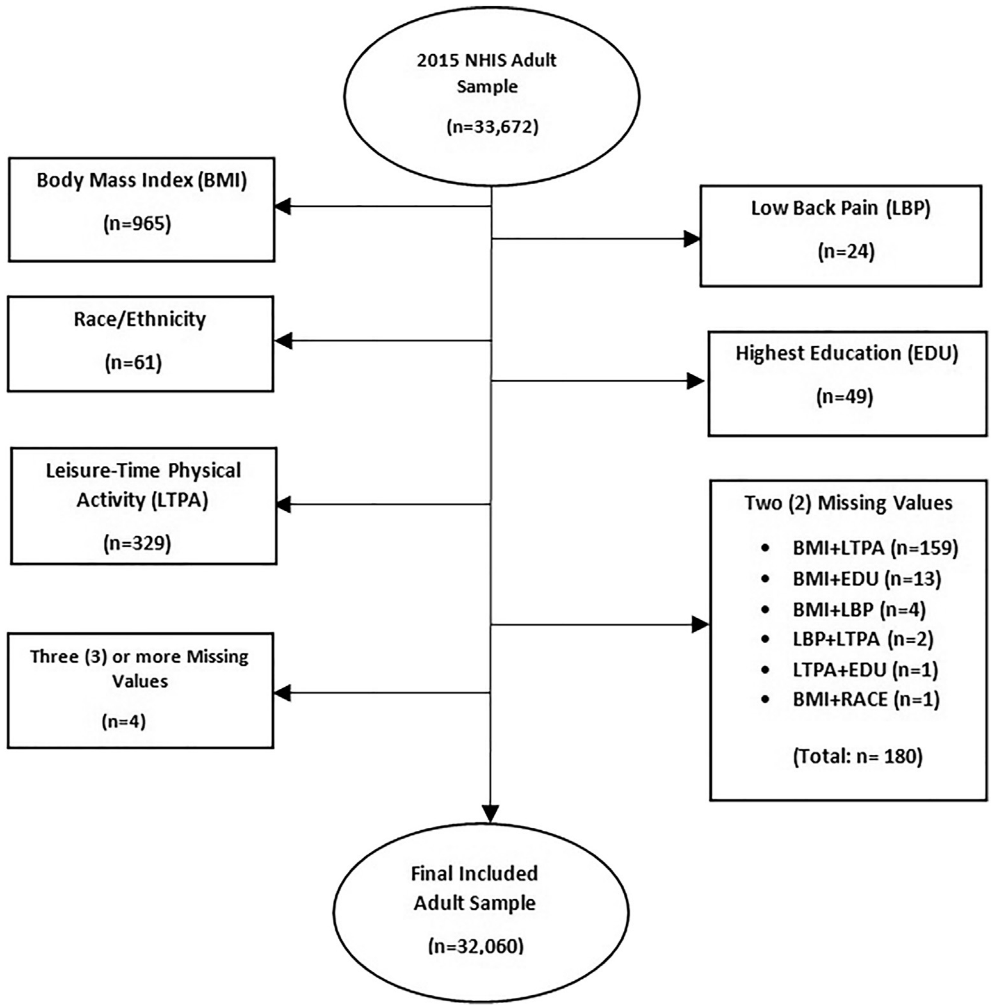

Fig 1. *Number of exclusions by reason.* NHIS, *National Health Interview Survey.*

of LBP were higher for obese white men, obese white women, and obese nonwhite women, after adjustment for covariates. There was no statistically significant difference in the adjusted odds of LBP among obese nonwhite men compared with normal-weight white men. The adjusted odds of LBP were statistically significantly lower in overweight nonwhite men compared with normal-weight white men. There were no statistically significant differences in the adjusted odds of LBP among overweight, white males; overweight, white females; or overweight, nonwhite females when compared with normal-weight white men. Further, the adjusted odds of LBP were lower in normal-weight nonwhite men and normal-weight nonwhite women compared with normal-weight white men. The normal-weight white female group did not have statistically significant differences in the adjusted odds of LBP compared with normal-weight white men (Table 3).

For all univariate and multivariable analyses, none of the goodness-of-fit tests were statistically significant, which indicates all models demonstrated good fit (refer to footnotes of Tables 2 and 3).

Discussion

This study determined that BMI was associated with 3-month prevalence of reported LBP in US adults, evidenced by a statistically significant increase in LBP odds with each successive increase in BMI category. Specifically, overweight and obese adults had a 21% and 55% increase in LBP odds, respectively, compared with adults with normal BMI (adjusted for age, sex, race/ethnicity, educational attainment, and leisure-time physical activity). This increase in odds of LBP may be clinically relevant; however, additional prospective evidence is needed to confirm these associations.

These findings provide an update on a paper by Yang and Haldeman[23] that reported on the association between

Table 1. *Weighted Demographic Characteristics, Activity Level, BMI, and Low Back Pain Status of Participants (N = 32 060)*

Characteristics	Unweighted Frequency	Weighted Frequency	Weighted Percentage (%) in Population	Weighted Percentage (%) With LBP
Total adult population	32 060	230 244 255	100	30.0
Age, y, mean (SE)	47.0 (0.2)			
Age group				
18-39	10 894	88 582 681	38.4	23.1
40-59	10 579	80 037 471	34.8	33.4
60+	10 587	61 624 103	26.8	35.3
Sex				
Male	14 624	113 245 826	49.2	28.5
Female	17 436	116 998 429	50.8	31.3
Race/ethnicity				
White	19 915	149 586 592	64.9	31.8
Black	4235	26 905 713	11.7	28.4
Hispanic	5311	36 062 490	15.7	26.8
Asian	1821	13 130 800	5.7	19.0
American Indian and Alaskan Native	246	1 362 167	0.6	37.7
Multiple	532	3 196 493	1.4	34.6
Educational attainment				
Less than associate degree	15 782	99 698 177	43.3	33.7
Associate degree or higher	16 278	130 546 078	56.7	27.1
Leisure-time physical activity				
Inactivity (0 min/wk)	10 488	70 608 160	30.7	36.2
Insufficient activity (<150 min/wk)	6330	46 020 154	20.0	31.8
Sufficient activity (≥150 min/wk)	15 242	113 615 941	49.3	25.4
BMI categories				
Underweight (BMI <18.5 kg/m^2)	593	4 379 328	1.9	24.1
Normal weight (18.5 ≤ BMI < 25 kg/m^2)	10 688	78 959 209	34.3	25.0
Overweight (25 ≤ BMI < 30 kg/m^2)	10 898	77 736 639	33.8	29.6
Obese (BMI >30 kg/m^2)	9881	69 169 079	30.0	36.4
Mean BMI (SE)	27.9 (0.1)			
LBP (past 3 mo)				
Yes	10 072	68 962 266	30.0	
No	21 988	161 281 989	70.0	

BMI, body mass index; *LBP,* low back pain; *SE,* standard error.

behavioral factors (one of which was obesity) and LBP using NHIS data from 2009-2012. Similar to our study using the updated 2015 NHIS dataset (released by the Centers for Disease Control and Prevention in June 2016), the paper by Yang and Haldeman[23] reported increased odds (95% CI) of LBP in the overweight and obese (OR: 1.14 [1.10-1.18] and 1.42 [1.37-1.48], respectively), relatively to normal-weight participants. However, potential interaction by race and sex was not considered. Further, additional adjustment for leisure-time physical activity was not conducted in the BMI-LBP analysis. Our results are also congruent with the meta-analysis conducted by Shiri et al.[20] However, a novel finding of this analysis was that both sex and race/ethnicity modified the association between BMI and LBP. In a previous study examining the association between BMI and LBP by sex,[38] women had a higher odds of LBP than men in each BMI category compared with normal-weight individuals. The results from the present study generally supported this finding. However, differences in the magnitude and direction of the measures of association were also determined to vary by race/ethnicity groups (ie, white vs nonwhite). Nonetheless, obese women may be at a higher risk of LBP compared with their male counterparts because of reduced strength and size of lumbar paraspinal muscles.[39] These sex-related differences may also be explained by pregnancy because the majority of women experience LBP during pregnancy.[40] Menstruation is another physiological cause for LBP specific to women.[10]

Table 2. *Weighted Crude and Adjusted Odds Ratio of Low Back Pain by BMI and Other Covariates*

Variable	OR (95% CI)	aOR (95% CI) [a]
Main exposure: BMI [b]		
Normal weight (BMI <25 kg/m^2)	Reference	Reference
Overweight (25 ≤ BMI < 30 kg/m^2)	1.27 (1.16-1.38)	1.21 (1.11-1.32)
Obese (BMI >30 kg/m^2)	1.72 (1.60-1.85)	1.55 (1.44-1.67)
Covariates		
Age group		
18-39	Reference	Reference
40-59	1.66 (1.53-1.81)	1.52 (1.40-1.65)
60+	1.81 (1.67-1.97)	1.53 (1.41-1.67)
Sex		
Male	Reference	Reference
Female	1.14 (1.07-1.22)	1.15 (1.08-1.22)
Race/ethnicity		
White	Reference	Reference
Black	0.85 (0.77-0.93)	0.78 (0.71-0.85)
Hispanic	0.79 (0.71-0.86)	0.75 (0.68-0.83)
Other (Asian, AIAN, multiple)	0.65 (0.57-0.74)	0.73 (0.64-0.84)
Educational attainment		
Less than associate degree	Reference	Reference
Associate degree or higher	0.73 (0.68-0.78)	0.78 (0.73-0.84)
Leisure-time physical activity		
Sufficiently active (≥150 min/wk)	Reference	Reference
Inactive (0 min/wk)	1.67 (1.54-1.81)	1.44 (1.32-1.57)
Insufficiently active (<150 min/wk)	1.37 (1.26-1.49)	1.24 (1.13-1.35)

AIAN, American Indian and Alaskan Native; *aOR,* adjusted odds ratio; *BMI,* body mass index; *CI,* confidence interval; *df*, degrees of freedom; *OR,* crude odds ratio.

[a] Odds ratios are adjusted for the following variables: age, sex, race/ethnicity, BMI, highest level of education, and leisure-time physical activity.

[b] Goodness-of-fit tests were not statistically significant for the logistic regression model with covariates (F = 0.50, P = .87, df = 300) and without ($F = 6.56 \times 10^{-13}$, P = .99, df = 300).

Given the broad age ranges included in the 2015 NHIS (ie, ≥18 years), it is quite possible that some female participants could have been pregnant and/or menstruating when data were being collected. Finally, it has been documented in the literature that women may have a lower threshold for pain[41] and might be more likely to report pain compared with men, which may have also influenced the LBP estimate. However, these potential sex-related differences in pain tolerance and/or reporting cannot be confirmed given that these data are not collected in the NHIS.

Our unique sample from the NHIS enabled us to explore the potential modifying role of race and ethnicity on the association between BMI and LBP. To date, few studies have specifically examined the role of race and ethnicity. This may be explained by the homogenous nature of the analytic samples of previous studies, where the number of nonwhite participants was too small to examine the associations within distinct race and ethnicity strata.[19,20] In a 2002 study by Deyo et al,[6] a higher proportion of LBP was reported in whites compared with Hispanics, blacks, or Asians. This finding was also reported in the present study (Table 2). However, these findings should be interpreted with caution given that there are established racial differences in estimates of reported pain. For example, blacks have been found to underreport pain intensity to their physicians compared with whites.[42] In another study, Hispanics were reported to be less likely to seek medical treatment for pain compared with whites.[43] Research on pain reporting among Asians and other racial and ethnic groups is scarce.

Consequently, findings from earlier studies that did not consider sex and/or race and ethnicity as potential effect measure modifiers should be interpreted with caution, because it was determined in the present study that the adjusted measure of associations statistically significantly varied in magnitude and direction across sex and race and ethnicity strata.

Potential Clinical Implications

For health care providers who often see patients with LBP (eg, chiropractors), this study carries several clinical implications. First, routine height and weight measurements with BMI calculation should be made. Moreover, clinicians should consider sex, race, and ethnicity when assessing the

Table 3. *Weighted Crude and Adjusted Odds Ratio of Low Back Pain by BMI, Stratified by Sex and Race/Ethnicity*

Category	OR (95% CI) [a]	aOR (95% CI)[a,b]
Normal weight, white male (reference)	1.00	1.00
Normal weight, nonwhite male	0.63 (0.52, 0.76) [c]	0.62 (0.51, 0.76) [c]
Normal weight, white female	0.95 (0.82, 1.11)	0.94 (0.81, 1.09)
Normal weight, nonwhite female	0.75 (0.63, 0.89) [c]	0.73 (0.61, 0.87) [c]
Overweight, white male	1.12 (0.96, 1.32)	1.06 (0.91, 1.24)
Overweight, nonwhite male	0.86 (0.73, 1.02)	0.80 (0.68, 0.94) [c]
Overweight, white female	1.33 (1.12, 1.58) [c]	1.18 (1.00, 1.41)
Overweight, nonwhite female	1.02 (0.86, 1.19)	0.92 (0.78, 1.08)
Obese, white male	1.44 (1.24, 1.67) [c]	1.28 (1.10, 1.48) [c]
Obese, nonwhite male	1.01 (0.84, 1.21)	0.91 (0.75, 1.10)
Obese, white female	1.84 (1.58, 2.14) [c]	1.58 (1.36, 1.84) [c]
Obese, nonwhite female	1.60 (1.36, 1.87) [c]	1.36 (1.16, 1.60) [c]

aOR, adjusted odds ratio; *BMI,* body mass index; *CI,* confidence interval; *df*, degrees of freedom; *OR,* crude odds ratio.

[a] Goodness-of-fit tests were not statistically significant for the interaction model with covariates ($F = 1.00$, $P = .44$, $df = 300$) and without ($F = 6.85 \times 10^{-12}$, $P = .99$, $df = 300$).

[b] Adjusted for age, highest level of education, and leisure-time physical activity.

[c] Statistically significant findings.

relationship between BMI and LBP. Despite the use of a cross-sectional design, our findings support the continued evaluation of these associations using longitudinal data to confirm causality. Further, given the confirmed health risk associated with overweight and obesity,[44,45] weight loss strategies should be included in any treatment plan.

Strengths and Limitations

This study has several strengths. First, data from a large and nationally representative sample of the US adult population were used, which optimizes the potential for generalizability of these findings. Further, the large sample size provided the unique opportunity to examine the potential effect modifying role of sex, race, and ethnicity combined. Finally, key factors that have been reported in the literature to influence the measure of association between obesity and LBP were included in the analysis as covariates, which reduces the potential for residual confounding.

Limitations. The study design was cross-sectional; therefore, temporality or causality between BMI and LBP cannot be inferred. The cross-sectional study design is ideal for hypothesis generating to better guide future work in this area. The exposure and outcome variables, and several of the covariates used in this study were participant reported. It is well established in the literature that participant-reported data are at risk for recall bias and potential for misclassification. However, previous studies in adults have reported a high correlation between self-reported and measured height and weight.[46,47] Differences between the analytic and excluded sample were noted, which increases the potential for selection bias. Further research is needed to validate a causal link and identify potential high-risk subgroups to reduce the public health burden attributable to LBP.

Conclusion

Findings from our study suggest that overweight and obesity were associated with increased odds of low back pain in nationally representative sample of US adults. Also, important differences in the observed measures of association were identified by sex and racial and ethnic groups. Based on these preliminary findings, health care providers may consider implementing BMI assessment into their clinical practice.

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Contributorship Information

Concept development (provided idea for the research): T.P., K.P.G.
Design (planned the methods to generate the results): T.P., A.P., K.P.G.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): K.P.G.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): T.P.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): T.P., A.P., K.P.G.
Literature search (performed the literature search): T.P.
Writing (responsible for writing a substantive part of the manuscript): T.P.
Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): A.P., K.P.G.

Practical Applications

- Findings from our study highlight the potential role of body weight in the development of LBP.
- Clinically, patients can be counseled on their odds of LBP based on weight status (body mass index).
- Additionally, results from our multivariable analysis help health care professionals identify high-risk subgroups of developing LBP, and these specific groups can be managed accordingly.

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