Concomitance of Obesity and Overweight with Disc Height and Disc Herniation in Lumbar Spine

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Abstract

Background & Aim: Low back pain is the most debilitating condition, and can lead to decreased physical function, compromised quality of life, and psychological distress. Several studies have been conducted to recognize the risk factors of low back pain, but despite of strong relationship between obesity and low back pain, the underlying mechanisms are unclear. The aim of this study was to evaluate the association between obesity/overweight and disc height and disc bulging at each level and total levels in lumbar vertebra, considering occupational risk factors.

Methods & Materials/Patients: This is a cross-sectional study on 102 patients with low back pain referring to MRI department in Poursina hospital in Rasht. Body mass index (kg/m^2) categories modified for Asian populations based on World Health Organization guidelines were used. Disc height and disc herniation were evaluated in sagittal T_1, sagittal T_2 and axial T_2 MRI images. We used four risk factors agreed by US-NIOSH (USA-National Institute for Occupational Safety and Health), to evaluate the occupational risk factors. Regression test was used for statistical analysis.

Results: Of the 102 patients, 36.3% were men and 63.7% were women. The age range was 15 to 75 years. Results showed that 26.5% of patients had normal body mass index, 39.2% were overweight and 34.3% were obese. Low, moderate, and high level of occupational risk factors were distributed as 36.3%, 17.6%, and 46.1%, respectively. Analysis with regression test showed that the relationship between obesity and overweight and disc height was negative at total levels and all levels, unless L_5-S_1. At L_5-S_1 level, there was no association. There was a positive relationship between obesity and total score of disc herniation at L_1-S_1. There was no association between overweight and total score at this level. At L_1-L_2, L_2-L_3 and L_5-S_1, there were no association between obesity and overweight and disc herniation, and at L_3-L_4 and L_4-L_5, there were negative relationships between obesity and disc herniation.

Conclusion: Our study noted the positive and significant association between obesity/overweight and disc degenerative changes in lumbar spine. Since there is abundant evidence in the literature demonstrating the strong association of disc degeneration on MRI with low back pain, prevention and treatment of being overweight or obese must be a public health priority.

Keywords: Body Mass Index; Intervertebral Disc; Spine

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Introduction

Low back pain (LBP) is defined as pain in the area on the posterior aspect of the body from the lower margin of the twelfth ribs to the lower gluteal folds with or without pain referred into one or both lower limbs that lasts for at least one day [1]. A study, a systematic review of the global prevalence of low back pain including general population studies between 1980 and 2009 (A total of 165 studies from 54 countries) was published. The mean point prevalence was 18.3%, and lifetime prevalence was 38.9% [2]. LBP is the most debilitating condition, and can lead to decreased physical function, compromised quality of life, and psychological distress [3].

Several studies have been conducted to recognize the risk factors of LBP. In one study, the authors systematically searched the Medline (National Library of Medicine, Bethesda, Maryland) and Embase (Elsevier, Amsterdam, the Netherlands) databases until May 2009, and 95 studies were reviewed, and 33 studies were included in the meta-analyses. In cross-sectional studies, obesity was associated with increased prevalence of low back pain in the past 12 months (pooled odds ratio (OR)=1.33), seeking care for low back pain (OR=1.56), and chronic low back pain (OR=1.43) [4]. Despite of strong relationship between obesity and LBP, the underlying mechanisms are unclear. A number of studies have focused on examining the relationship between obesity and structures of the spine, in particular the lumbar disc. Several studies have been directed to identify the relationship between obesity and disc height and disc herniation, some of them have examined disc height at a single lumbar disc level [5], others have reported aggregate measures at levels from L_1 to L_4 [6,7]. However, no study to date has examined the effect of high body mass index (BMI) on disc height at different levels of lumbar spine [8]. The studies about disc herniation are similar. Moreover, in majority of these studies, occupational risk factors are ignored.

The aim of this study is to evaluate the association between obesity/overweight and disc height and disc bulging at each level and total levels in lumbar vertebra, considering occupational risk factor.

Methods and Materials/Patients

This was a cross-sectional study on 102 patients with LBP referring to MRI department in Poursina hospital in Rasht city. The range of age was 15 to 75 years. Exclusion criteria were congenital diseases of lumbar spine, spondylolysthesis, previous surgery of lumbar spine, malignancy and infectious diseases of lumbar spine.

Height was measured in centimeter (cm) using a stadiometer, and weight was measured in kilogram (kg) using an electronic scale. BMI (kg/m^2) categories modified for Asian populations based on World Health Organization guidelines were used. Individuals with a BMI of <18.5 kg/m^2 were classified as underweight, those with a BMI of 18.5–23.0 kg/m^2 were considered as normal, those with a BMI of 23.0–27.5 kg/m^2 were categorized as overweight, and those with a BMI of >27.5 kg/m^2 were classified as obese [9].

Disc height was measured on midsagittal MRI images from the middle of the superior border of the disc to the middle of the inferior border of the disc in millimeter (mm). Herniation was defined as a localized displacement of disc material beyond the limits of the intervertebral disc, less than 50% of disc circumference. Herniation can be seen in three forms. Protrusion is present if the greatest distance, in any plane, between the edges of the disc material beyond the disc space is less than the distance between the edges of the base, in the same plane. Extrusion is present when, in at least one plane, any one distance between the edges of the disc material beyond the disc space is greater than the distance between the edges of the base, or when no continuity exists between the disc material beyond the disc space and that within the disc space. Sequestration is present if the displaced disc material has lost completely any continuity with the parent disc [10,11]. We used scoring for evaluation of severity of herniation: score=0 for absence of herniation, score=1 for protrusion and score=2 for extrusion. We did not have any case of sequestration.

MRI imaging scans were performed using a one Tesla MR unit (Philips intra), and the following scans were performed: sagittal T1 (time to recovery: 375, time to echo: 11), sagittal T2 (TR: 3000, TE: 120) and axial T2 from L_1 to S_1. Images were reported by a radiologist experienced in musculoskeletal MRI. We used four risk factors agreed by US-NIOSH (USA-National Institute for Occupational Safety and Health), to evaluate the occupational risk factors (Table 1) [12].

Table 1. Occupational Risk Factors for Degenerative Disk Diseases

Risk Factors	Level	Description
Prolonged Sitting	Low	≤ 4 hours/day and <1 year
Bending/Twisting	Moderate	≤ 4 hours/day and 1-10 year or > 4 hours/day and ≤ 5 years
	High	≤ 4 hours/day and >10 years or > 4 hours/day and >5 years
Whole Body Vibration	Low	≤ 4 hours/day and ≤ 1 year
Lifting	Moderate	≤ 4 hours/day and 1-5 year or > 4 hours/day and ≤ 2.5 years
	High	≤ 4 hours/day and >5 years or >4 hours/day and >2.5 years

Data of occupational risk factors and exclusion criteria were obtained from telephone interview with patients.

Regression test was used for statistical analysis. Using multivariate regression test, we counteracted the effect of variables affecting dependent variables (age, sex, occupational risk factors), to assess the effect of independent variables (obesity and overweight) [13].

Results

Of the 102 patients, 36.3% were men and 63.7% were women. The range of age was 15 to 75 years. Results showed that 26.5% of patients had normal BMI, 39.2% were overweight and 34.3% were obese. Distribution of levels of occupational risk factor included 36.3% low, 17.6% moderate and 46.1% high. Table 2 shows the mean values of disc height at different levels and total levels.

Table 2. Mean Values of Disc Height at Different Levels

	Obese	Overweight	Normal
L_1-L_2	5.48	5.94	6.92
L_2-L_3	6.52	7.06	8.56
L_3-L_4	7.52	7.33	9.85
L_4-L_5	8.59	7.74	10.48
L_5-S_1	7.54	8.05	8.46
Total	6.62	6.74	8.21

Analysis with regression test showed that the relationship between obesity and overweight and disc height was negative at total levels and all levels, unless L_5-S_1. At L_5-S_1 level, there was no association. Regression coefficients are shown in table 3. Percentage of herniation in different levels and total score of herniation are shown in table 4.

Table 3. Regression Coefficients in Analysis of Association between BMI and Disc Height

	Obesity	Overweight
L_1-L_2	-1.539	-0.669
L_2-L_3	-2.002	-1.337
L_3-L_4	-2.288	-2.315
L_4-L_5	-2.176	-2.742
Total	-9.344	-8.140

Table 4. Percentage of Herniation in Different Levels

	Obese	Overweight	Normal
L_1-L_2	3%	0%	0%
L_2-L_3	26%	23%	22%
L_3-L_4	51%	30%	30%
L_4-L_5	80%	55%	52%
L_5-S_1	57%	53%	70%
Total Score	2.6	1.7	1.81

Results showed that there was a positive relationship between obesity and total score of disc herniation at L_1-S_1. There was no association between overweight and total score at this level. At L_1-L_2, L_2-L_3, and L_5-S_1, there were no association between obesity and overweight and disc herniation, and at L_3-L_4 and

L_4-L_5, there were a negative relationship between obesity and disc herniation. Regression coefficients are shown in table 5.

Table 5. Regression Coefficients in Analysis of Association between BMI and Disc Herniation

	Obesity
L_3-L_4	-0.941
L_4-L_5	-1.348
Total Score	0.800

Discussion

Results of our study showed that obesity and overweight had a significant negative relationship with disc height at all levels, unless L_5-S_1. This relationship was also seen in total levels. These are similar to results of Donna and colleagues' study in 2014 about correlation between obesity and disc height in lumbar spine, in which the mean and total disc heights were less in the obese individuals compared with the nonobese individuals (mean: 1.04 vs 1.14, total: 4.17 vs 4.56). Also the mean disc heights were less in the obese individuals compared with the nonobese individuals at L_1-L_2 and L_3-L_4 [8].

Samartzis and colleagues in their study in China in 2001-2009 found that BMI (Asian-modified groups) was significantly higher in subjects with disc degeneration, including decreased signality in early stages and decreased height in late stages, (mean ± SD = 23.3 ± 3.2 kg/m^2) than in subjects without disc degeneration (mean ± SD = 21.7 ± 3.1 kg/m^2) (P<0.001). Individuals who were overweight and those who were obese had an increased likelihood of multilevel disc degeneration involvement (P<0.001). The mean ± SD degenerative disc disease scores for underweight, normal, overweight, and obese subjects were 1.5 ± 2.1, 2.5 ± 2.5, 3.3 ± 2.8, and 3.8 ± 2.8, respectively (P< 0.001), indicating an increase in the severity of disc degeneration with increased BMI [14]. These results are compatible with the results of our study.

In another study conducted by Samartzis et al. in juvenile population in China in 2011, adjusted multivariate logistic regression modeling demonstrated that Asian-modified BMI values in the overweight or obese range had a significant association with juvenile disc degeneration (odds ratio = 14.19; 95% confidence interval = 1.44 to 140.40; p = 0.023). Also, overweight and obese individuals had greater severity of disc degeneration than underweight and normal-weight individuals (p=0.036) [15]. These results also are compatible with the results of our study.

In a study conducted by Lidar and colleagues in 2012, it was found that in individuals with morbid obesity, with an average reduction in BMI of 42.8 ± 4.8 kg/m^2 to 29.7 ± 3.4 kg/m^2 (P<0.001), the L_4-L_5 disc space height increased from 6 ± 1.3 mm indicated before operation to 8 ± 1.5 mm one year after operation (P<0.001) [5]. This result, indicating adverse relationship between BMI and disc height, corresponds to our result in L_4-L_5.

Our results identified that there is a significant positive relationship between obesity and total disc herniation score in L_1 to S_1. In the study carried out by Samartzis and colleagues in 2011, the results showed that BMI was grater in individuals with disc degeneration rather than control group. Also 66% of affected individuals had bulging or extrusion, while there was no case of bulging or extrusion in control group, and this difference was significant (p<0.05) [15]. In another study by Samartzis et al. in 2014, total disc bulge/extrusion score significantly increased in elevated BMI categories (p<0.001). Multivariate analyses adjusting for covariates noted that elevated BMI was significantly associated with disc bulge/extrusion (underweight OR: 0.71; overweight OR: 1.26; obese OR: 1.78). Total disc bulge/extrusion (TDBE) score (OR: 1.36) and obesity (OR: 1.68) were significantly related with sciatica. This study definitely noted that overweight and obesity significantly increased the likelihood of having lumbar disc herniation, its global severity, and the risk of developing sciatica [16]. The results of our study agrees and corresponds with those of Samartzis et al.

Conclusion

Our study noted the positive association between obesity/overweight and disc degenerative changes in lumbar spine and its complications including decreased disc height and disc herniation. The present study clearly illustrates that being overweight or obese is a strong determinant related to disc degeneration of the lumbar spine. Public should be well informed that weight control is important for preventing low back pain as it is for other conditions, such as heart disease and diabetes. Prevention and treatment of being overweight or obese must be a public health priority.

Limitations

Data of this study are withdrawn from MRI department investigating the diseased people with different levels of LBP so they are not identified and included in the variables. The severity of illness might have affected the changes measured in static images.

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Conflicts of Interest

The authors declare no conflict of interest.

Author's Contribution

Conception and Design: Dr. Arzpeima. Data Collection: Dr. Sedighi Moghadam Pour. Drafting the Article: Dr. Sedighi Moghadam Pour. Critical Revising the Article: All authors. Reviewing Submitted Version of Manuscript: All authors. Approving the Final version of the Manuscript: All authors.

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