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Research paper

Pain and musculoskeletal impairments in patients with high body mass index

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summary The impact of obesity on pain has been addressed in few studies. Pain is influenced by several factors so we aimed to investigate patients with a high body mass index (BMI) from various aspects including pain, depressive symptoms, degenerative findings and bone mineral density (BMD) in order to explore possible correlations. Seventy-four consecutive female patients seeking treatment for various pain problems from the outpatient clinics of the Department of Physical Medicine and Rehabilitation (Hacettepe University) were included in the study. A questionnaire evaluating sociodemographic factors and medical history was completed by the researchers. Anthropometric measurements of the patients were gathered. A body map, a visual analogue scale and a numeric scale were used to measure pain. Beck Depression Inventory (BDI) was used for depressive symptoms. Radiographic evaluation included anteroposterior and lateral knee, anteroposterior pelvis, anteroposterior and lateral lumbar spine, and lateral feet. BMD measurements of lumbar spine and femur were accomplished using Dual-Energy X-ray Absorptiometry (DEXA). The mean age of the patients was 52.70 ± 11.04 years (25–78); mean body mass index (BMI) was 31.19 ± 5.73 (21.91–47.27). Patients with BMI<30 ($n = 30$) and ⩾30 ($n = 44$) were compared. BDI scores were similar between the two groups but educational status and number of painful sites were found to be different. Pain in the upper extremities and knees was statistically significantly higher in the patients with BMI ⩾ 30. BMI was negatively correlated with the educational status of the patients but positively correlated with the number of painful sites on the body map. The presence of Kellgren Lawrence grade 2 or higher degenerative findings in the knees was found to be significantly higher in the group with BMI ⩾ 30. Also the presence of grade 2 or higher degenerative findings in the knees was associated with pain in that joints ($\chi^2 = 9.178$, $P = 0.002$) but not in the hips or lumbar region. BMD measurements at all sites except femoral trochanter were statistically significantly higher in patients with BMI ⩾ 30. Obesity has beneficial effects on BMD but adverse effects on degenerative findings and pain.

Key words: Obesity; pain; depression; osteoarthritis; bone mineral density.

introduction

Obesity is an unsolved therapeutic problem.[1] According to the World Health Organization (WHO) obesity prevalence is increasing worldwide at an alarming rate in both developed and developing countries, and women generally have higher rates of obesity than men, although men may have higher rates of overweight.[2]

To date, few studies have focused on the relationship between body mass index (BMI) and pain. It was shown that healthy pain-free obese subjects have reduced mechanical pain thresholds.[3] Also, experimental studies have

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pointed out a possible correlation between obesity and nociceptive stimuli in rats.[4] Peltonen *et al.* claimed that self-reported work-restricting pain in the neck and back area and in the hip, knee and ankle joints was more common in the obese subjects than in the general population.[5] Webb *et al.* have reported that high BMI is a significant predictor of spinal pain with disability.[6]

Obesity has a negative impact on osteoarthritis (OA) because of the mechanical load on joints and activation of proinflammatory cytokines that promote joint destruction.[7] BMI was found to be associated with more frequent osteophytes at both dorsal and lumbar spine;[8] the relationship was stronger at the dorsal spine. Hart and Spector have investigated the relationship between obesity and radiologically confirmed OA in the knee, carpometacarpal (CMC), distal interphalangeal (DIP) and proximal interphalangeal (PIP) joints and they have concluded that body weight is a powerful predictor of OA of the knee in the middle aged woman and a modest predictor of DIP and CMC OA.[9]

Pain is influenced by several factors so we aimed to investigate our patients with high BMI from various aspects including pain, depressive symptoms, degenerative findings and bone mineral density (BMD) measurements in order to reveal possible correlations between them.

materials and methods

A total of 74 consecutive female volunteers seeking treatment for various pain problems from the outpatient clinics of the Department of Physical Medicine and Rehabilitation (Hacettepe University) were evaluated. Volunteers provided informed consent and the research was performed following the Declaration of Helsinki principles. Researchers (AA, RC) completed a questionnaire about sociodemographic factors and medical history. In this questionnaire patients were asked about their pain using a body map, a visual analogue scale (VAS) (0–100 mm) and a numeric scale (0–10).[10] All anthropometric measurements were made by the same examiner (AA) in accordance with WHO recommendations.[11] The weight of the patients was measured using a calibrated scale by the same examiner. Height was measured in bare feet and waist and hip circumferences taken; triceps skin fold thickness was noted. BMI was calculated by dividing weight (in kilograms) by the square of height (in meters). Cut-off points of obesity were determined according to the recommendations of WHO. BMI between 18.5 and 24.99 is the normal range for an individual. BMI between 25.0–29.99 indicates grade 1 overweight, 30.0–39.99 indicates grade 2 overweight, $\geqslant$40.00 indicates grade 3 overweight.[11] For statistical purposes, patients were divided into two groups: patients with BMI < 30 ($n = 30$) and those with BMI $\geqslant 30$ ($n = 44$).

The Beck Depression Inventory (BDI) is a 21-item self-report rating inventory measuring attitudes and symptoms of depression. In BDI, a higher score means that the patient is more depressed.[12] We checked our patients for depression as a possible confounding factor for painful conditions.

Radiographic evaluation included anteroposterior and lateral knee, anterior pelvis, anteroposterior and lateral lumbar and lateral feet X-rays. Radiographs of the knees, hip and lumbar spine were evaluated according to the Kellgren-Lawrence system[13] by the same examiner who was blind to clinical examination of the patients (SA). BMD measurements of lumbar spine and femur were accomplished using Dual-Energy X-ray absorptiometry (DEXA: Hologic QDR-4500 A, Waltham, MA). We considered patients with either femoral or lumbar BMD-2.5 SD or lower as osteoporotic.[14]

Statistical analyses were performed by SPSS for windows, version 11.0. Age, BMI, VAS, BMD measurements were normally distributed. BDI scores were not normally distributed. Differences in the interval variables were tested using a t-test for normally distributed variables and Mann–Whitney U-test for the remaining variables. Pearson's correlation matrix was used to evaluate the relationship between BMI and other clinical parameters. For ordinal variables such as education, presence of radiographic degenerative changes and localization of current pain problems the chi-square test was utilized. We considered 30 as a cut-off point for obesity following Larsson and Mattson.[15] We also compared patients according to degenerative changes. We compared Grade 0 and 1 with higher grades. A P-value <0.05 was accepted as statistically significant.

results

Characteristics of the study population grouped according to BMI are summarized in Table I. The mean age and height were similar in both groups but all the other anthropometric parameters were significantly different. A total of 50 (67.6%) participants were housewives without other jobs, 18 (24.3%) were employed and 6 (8.1%) were retired. 63.9% had a family history of obesity. As regards educational status, 40% of subjects with BMI < 30 had had education for 5 years or less whereas 75% of the subjects with BMI $\geqslant 30$ had the same level of education. Educational status was statistically different between the two groups ($P = 0.002$). As far as chronic diseases are concerned, 18 patients (60%) with BMI < 30 and 22 (50%) patients with BMI $\geqslant 30$ had hyperlipidemia; 7 (23.3%) patients with BMI < 30 and 15 (34.1%) patients with BMI $\geqslant 30$ had hypertension.

The mean VAS score was 6.14 ± 2.60; the mean numeric pain scale score was 6.38 ± 2.57. The mean number of painful sites on the body map according to BMI groups and distribution of pain is summarized in Table II.

Table I.
Characteristics of the study population ($n = 74$)

Characteristics	BMI < 30 $N = 30$ Mean ± SD	BMI $\geqslant 30$ $N = 44$ Mean ± SD	P
Age (years)	55.43 ± 11.43	50.84 ± 10.49	0.079
Height (cm)	155 ± 5.96	154±4.67	0.382
Weight (kg)	60.82 ± 5.75	82.80 ± 11.10	0.0001*
BMI (kg/m^2)	25.49 ± 2.36	35.08 ± 3.71	0.0001*
Waist circumference (cm)	81.33 ± 7.53	98.34 ± 8.78	0.0001*
Hip circumference (cm)	101.63 ± 5.27	119.00 ± 8.49	0.0001*
Triceps skinfold thickness (cm)	3.62 ± 0.71	5.63 ± 0.80	0.0001*
Waist to hip ratio	0.80 ± 0.05	0.83 ± 0.04	0.013*

t-test for independent samples was utilised because variables were normally distributed.
* $P < 0.05$. BMI: Body mass index, SD: standard deviation.

Table II.
Current pain problems of the study population

Current pain problems	BMI < 30 $N = 30$ N, (%)	BMI $\geqslant 30$ $N = 44$ N, (%)	P
Hips	11, (36.7)	12, (27.9)	0.428
Knees	12, (40.0)	32, (74.4)	0.003*
Heels	6, (20.0)	10, (23.3)	0.741
Cervical	10, (33.3)	20, (46.5)	0.260
Lumbar	12, (40.0)	26, (60.5)	0.085
Upper extremities	5, (16.7)	21, (48.8)	0.005*
Mean number of painful sites on the body map	3.20 ± 2.07	5.55 ± 2.86	0.0001*

Chi-square test is used for statistical analysis.
* $P < 0.05$. BMI: body mass index.

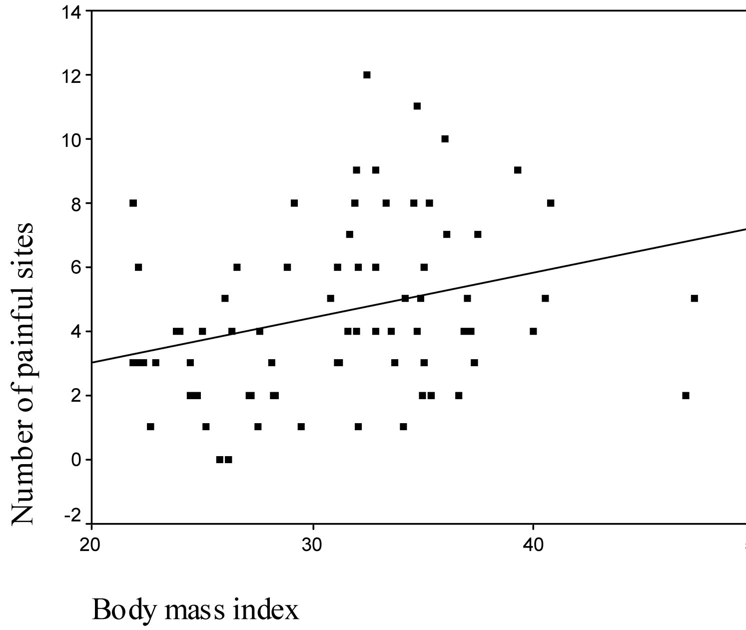

Figure 1. Correlation between body mass index (BMI) and number of painful sites on the body map ($r = 0.323$, $P = 0.005$).

Table III.
Distribution of patients according to radiographic findings of the knees, hips and lumbar spine

	Knees		Hips		Lumbar spine	
Degenerative findings	BMI < 30 (N, %)	BMI ⩾ 30 (N, %)	BMI < 30 (N, %)	BMI ⩾ 30 (N, %)	BMI < 30 (N, %)	BMI ⩾ 30 (N, %)
Absent	12 (41.4)	11 (26.2)	8 (28.6)	19 (43.2)	5 (17.2)	10 (23.3)
Grade 1	14 (48.3)	15 (35.7)	8 (28.6)	19 (43.2)	8 (27.6)	16 (37.1)
Grade 2	1 (3.4)	5 (11.9)	7 (25)	3 (6.8)	8 (27.6)	6 (14)
Grade 3	2 (6.9)	8 (19.0)	5 (17.8)	3 (6.8)	8 (27.6)	10 (23.3)
Grade 4	—	3 (7.2)	—	—	—	1 (2.3)

Non obese = BMI < 30 and obese = BMI ⩾ 30.

BMI was positively correlated with the number of painful sites on the body map ($r = 0.323$, $P = 0.005$) (Fig. 1). Considering that age is an effect modifier in this association, partial correlation controlling for age was computed. VAS scores were correlated with the number of painful sites ($r = 0.318$, $P = 0.008$). BMI was negatively correlated with the educational status of the patients ($r = -0.312$, $P = 0.007$).

The mean BDI score was 12.66 ± 9.13 (range: 1 to 46). BDI scores of patients with BMI < 30 was 12.5 ± 7.04 and BMI > 30 was 12.77 ± 10.43. The difference between groups was not statistically significant ($P = 0.422$). BMI was not correlated with BDI scores ($r = -0.097$, $P = 0.414$).

Distribution of patients according to radiographic findings of the knees, hips and lumbar spine is summarized in Table III. Twenty-seven patients (36.5%) had calcanear spurs on the lateral X-ray of the feet. Patients with BMI < 30 and BMI ⩾ 30 were compared according to the presence of degenerative findings. The presence of grade 2 or higher degenerative findings in the knees was found to be significantly higher in the group with BMI ⩾ 30 ($P = 0.009$, $\chi^2 = 6.74$) but not in the hip or lumbar region. Also the presence of grade 2 or higher degenerative findings in the knees was associated with pain in that joint ($\chi^2 = 9.178$, $P = 0.002$) but not in the hips or lumbar region.

Table IV.
Comparison of bone mineral density (gr/cm^2) of patients with BMI < 30 and ⩾ 30

	BMI < 30 ($N = 30$) Mean ± SD	BMI ⩾ 30 ($N = 44$) Mean ± SD	P
L1-4 (g/cm^2)	0.85 ± 0.15	0.97 ± 0.14	0.001*
Femoral neck (g/cm^2)	0.74 ± 0.18	0.85 ± 0.13	0.002*
Femoral trochanter (g/cm^2)	0.67 ± 0.19	0.72 ± 0.11	0.156
Femoral intertrochanter (g/cm^2)	1.01 ± 0.12	1.17 ± 0.16	0.0001*
Femoral total (g/cm^2)	0.84 ± 0.1	0.98 ± 0.13	0.0001*

* $P < 0.05$.

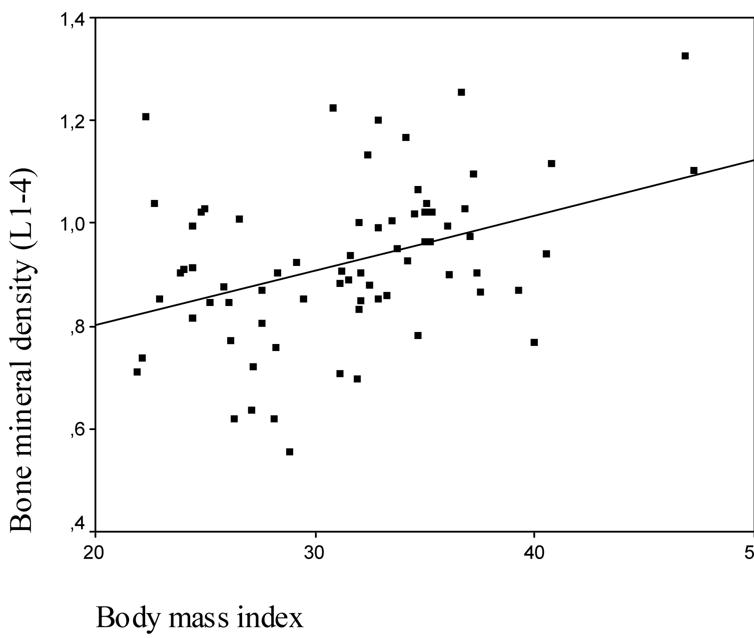

Figure 2. Correlation between body mass index (BMI) and L1-4 bone mineral density (BMD) ($r = 0.392$, $P = 0.001$).

BMD at all sites, except femoral trochanter, was significantly higher in patients with BMI ⩾ 30 (Table IV). Correlation of BMI with BMD values controlling for degenerative changes of that particular region (lumbar and femoral) were statistically significant at all sites ($P < 0.001$). The correlation between BMI and L1-4 BMD is shown in Fig. 2. The correlation between BMI and total femoral BMD is shown in Fig. 3.

discussion

In this study BMI was negatively correlated with the educational status of the patients and positively correlated with the number of painful sites. Pain in the upper extremities and knees were significantly higher in the group with BMI ⩾ 30. The presence of degenerative findings in the knees was significantly higher in the obese group. Also, degenerative findings in the knees were associated with pain in this region. BMD at all sites except femoral trochanter was significantly higher in obese patients. BMI and BMD were correlated at all sites.

Seidell *et al.* have assessed subjective health status in relation to overweight by administrating a list of 51 health complaints to 455 men and 790 women aged 26–66.[16] They concluded that BMI was correlated with the total number of complaints in women and also musculoskeletal system complaints were correlated with BMI in both sexes. In a study by Rosmond and Björntorp[1]

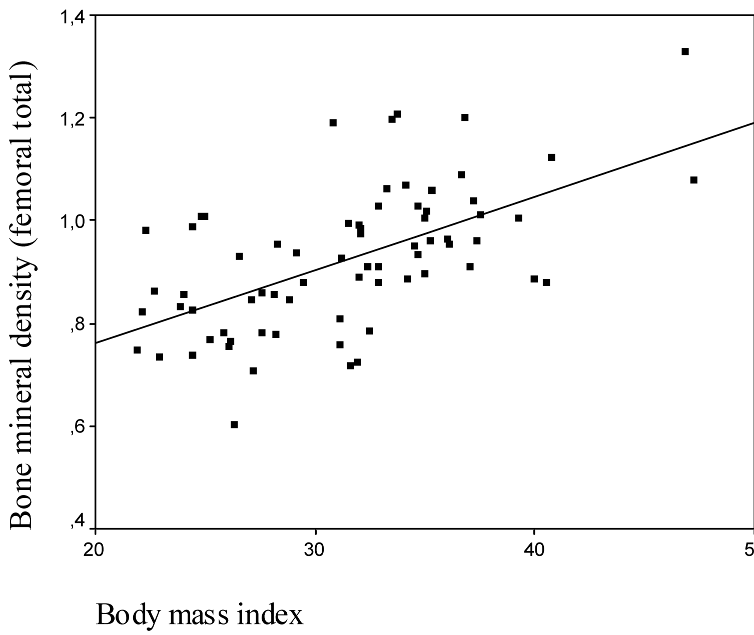

Figure 3. Correlation between body mass index (BMI) and total femoral bone mineral density (BMD) ($r = 0.697$, $P = 0.0001$).

in which measurements of obesity were analyzed in 284 men in relation to items about social, mental and physical well-being, it was concluded that men with BMI $\geqslant 25$ reported more pain in the legs when compared with their leaner counterparts. Tsuritani *et al.*[17] investigated the impact of obesity on musculoskeletal pain and disability in middle-aged women and found that a higher BMI was related to increased prevalence of leg pain. In a prospective cohort study conducted by Rissanen *et al.*,[18] BMI was found to be a strong predictor of early work disability and the increased risk was due to cardiovascular and musculoskeletal diseases. Peltonen *et al.* have investigated a random sample of subjects and have concluded that self-reported work-restricting pain in the neck and back area, and in the hip, knee and ankle joints was more common in the obese subjects than in the general population.[5] Similar to these studies we found that the number of painful points on the body map was positively correlated with BMI, and patients with BMI > 30 reported more pain in the upper extremities and knees when compared to patients with BMI < 30.

In the study by Seidell *et al.* social class was found to be negatively related to subjective health.[16] In this study, social class was defined as lower (unskilled and skilled manual workers), middle (lower level employees), or upper (higher level employees). Wamala *et al.* have examined the relationship between obesity and socioeconomic status among 300 healthy women aged 30–65 and stated that low socioeconomic status was a strong determinant of overweight and obesity among middle-aged healthy Swedish women.[19] In a study by Rosmond and Björntorp[20] it is stated that low educational status seems to be more frequent among respondents with BMI $\geqslant 25.05$ compared to those with BMI < 25.05. Similar to the above mentioned studies we have found that BMI was negatively correlated with educational status. Education is a strong determinant of obesity as it is a strong determinant for several chronic conditions.[21]

The psychological consequences of obesity is a matter of debate yet unresolved. Obese persons might well be expected to show greater psychological disturbances than normal-weight persons; however, such disturbances do not appear to be a problem in most overweight persons.[22] Roberts *et al.*[23] have investigated the association between obesity and depression on a community-based sample and they concluded that there has been sufficient diversity in results from epidemiologic studies to justify further studies on this issue. Carpenter *et al.*[24] stated that, among women, increased BMI was associated with both major depression and suicide ideation based on a national epidemiologic survey. In a study conducted by Stewart and Brook[25] on cross-sectional data from a general population of 5817 people it was found that heavier people are less anxious, less depressed and have higher scores on the mental health index. A study by Ross[26] conducted on a random sample of 2020 US adults showed that being overweight has no direct effect on depression in any social group, except among the well educated groups. In our group, BDI scores were found to be similar for obese and non-obese patients.

Overweight people are at high risk of developing knee OA and may be also at increased risk of hand and hip OA.[27] Few studies have examined different body parts simultaneously. In a study by Stürmer *et al.*,[28] 809 patients with knee or hip replacement due to OA were evaluated for OA of the knee, hip and hand. They found that obesity is strongly associated with bilateral knee OA. No association between obesity and bilateral hip or generalized OA was observed. In a case-control study conducted by Lau *et al.*,[29] patients with OA of hip and knee were compared with age and sex-matched controls. They concluded that subjects whose height and weight were in the highest quartile were at increased risk of OA of the hip and knee. Similar to findings of Lau *et al.*, the presence of degenerative findings in the knees was found here to be significantly higher in the group with a BMI of more than 30. But this relation was not observed in the hips, lumbar vertebrae and feet.

Few studies have addressed the complex relationship between degenerative findings, pain and high BMI. Hart and Spector[9] have studied 1003 women aged 45–64 to find the effect of quantity and distribution of body fat on the prevalence of radiologically confirmed OA in the knee, CMC, DIP and PIP joints. Knee OA was found to have the strongest association with BMI. However, differently from our study, radiological examination of lumbar spine, hips and feet were not included in this study. O'Neill *et al.*[8] have investigated distribution, determinants and clinical correlates of vertebral osteophytosis in a population based survey. They reported that increasing BMI was associated with more frequent osteophytes at both lumbar and dorsal spine, and self-reported back pain was associated with lumbar osteophytosis in men. Also Webb *et al.*[6] reported obesity as a predictor of back pain in their cross-sectional study. In our study we did not find statistically significant difference of either degenerative findings or pain of lumbar spine between obese and non-obese patients. Similar to the study of Hart and Spector[9] we found that the degenerative findings in the knees are significantly higher in the obese group and that degenerative changes in the knees were associated with pain in our patients.

According to previous findings, obesity exerts protection against osteoporosis[30,31] and there is a positive correlation between obesity and BMD.[32] Similar to previous findings, patients with BMI more than 30 had higher BMD values. Different from the previous studies we could examine this relationship controlling for degenerative changes as we performed both DEXA measurements and plain radiographs of lumbar and femoral regions.

Obesity offers protection against osteoporosis but has adverse effects on degenerative findings and pain at multiple skeletal sites. Our subjects were voluntary participants from our outpatient clinics so did not represent the community. However, we were able to examine patients from various aspects and clarify possible correlations of different variables. Further studies concerning the relationship between pain and obesity are required.

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