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ORIGINAL ARTICLE

The Effects of Obesity on Joint Integrity and Mobility. A Cross-Sectional Anatomical Study

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ABSTRACT

Background: Obesity is a major global health problem resulting in a great deal of musculoskeletal disorders, most prominently joint degeneration and impaired mobility.

Aims and Objectives: This study aimed and objective to assess the effect of obesity on joint integrity and mobility in Pakistani adults using radiographic and functional assessment.

Method: A cross-sectional study was conducted at different tertiary healthcare centres in Lahore, Pakistan, among n=150 participants (30–60 years). Nonobese (BMI < 25 kg/m², n=75) and obese (BMI ≥ 30 kg/m², n=75) were categorized as the participants. X-rays and MRI were used to assess joint integrity (joint space narrowing, osteophyte formation, and subchondral sclerosis). Range of motion (ROM) assessments and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain and functional limitations were used to evaluate mobility.

Results: Joint degeneration was significantly higher in obese individuals, 60% showed joint space narrowing, 68% showed osteophyte formation, and 55% showed subchondral sclerosis ($p < 0.001$). Knee flexion, hip abduction, and ankle dorsiflexion were significantly reduced in the obese group by 18, 22, and 25%, respectively ($p < 0.01$). Obese participants had markedly higher WOMAC scores for pain ($p < 0.001$) and stiffness ($p < 0.001$) and lesser functional impairment ($p < 0.001$).

Conclusion: obesity has a great negative effect on joint health, mobility, and functional capacity. Early weight management strategies, physiotherapy, and lifestyle modification are needed to avoid musculoskeletal complications of obesity. To decrease the burden of joint disorders, public health policies should focus on obesity prevention.

Keywords: Obesity, Joint Integrity, Mobility Impairment, Osteoarthritis, Range of Motion, Musculoskeletal Disorders, Adipokines, Radiographic Assessment.

INTRODUCTION

Obesity is a major public health problem worldwide, especially in the developing world, where it is increasing at an alarming rate, such as in Pakistan. The recent estimates show that more than half of the adult population of Pakistan is either overweight or obese, and the country is among the top ten worldwide in obesity rates[1]. The current trend is increasing urbanization, changes in dietary habits, and lifestyles of people becoming more and more sedentary. Obesity, which is an important risk factor for noncommunicable diseases, including cardiovascular disorders, type 2 diabetes, and metabolic syndrome, has gained much attention as a determinant of noncommunicable diseases but has received less attention regarding its impact on musculoskeletal health, in particular joint integrity and mobility. Although obesity is becoming a growing problem in obesity-related joint diseases, there has been little research done in Pakistan to determine the effect of obesity on joint health and functionality[2].

There is a mechanical and biochemical impact of obesity on joint function. The excessive body weight places additional strain on weight-bearing joints (knees and hips), which accelerates the wear of the cartilage and increases the risk of osteoarthritis. Excessive load leads to the structural integrity of joints, which is compromised, resulting in a reduction of joint space, formation of osteophytes, and subchondral bone sclerosis[3]. Besides mechanical factors, obesity results in systemic metabolic dysfunction by secreted adipokines, such as leptin, resistin, and adiponectin, that are known to promote chronic low-grade inflammation. The pro-inflammatory state further exacerbates joint degradation and is unable to regenerate cartilage and accelerate the progression of osteoarthritic changes. Furthermore, obesity-related metabolic syndrome and insulin resistance also promote joint pathology by enhancing oxidative stress and impairing chondrocyte function, hence promoting cartilage breakdown[3].

As with all these conditions, people with obesity also have decreased strength in their muscles, which further inhibits their joint mobility. Adipose tissue accumulation around joints not only reduces joint range of motion but also changes joint biomechanics, causing both compensatory gait abnormalities and increased energy expenditure for movement[4]. Obesity is associated with reduced flexibility, impaired balance, and diminished proprioception, all of which increase fall and functional disability risk. Particularly, knee and hip joint mobility is severely restricted, which causes difficulty in performing such activities of daily living as walking, climbing stairs, or standing for a long time. As a result of these impairments, obesity-related mobility restrictions can have a huge impact on overall quality of life, with the potential for further weight gain in a perpetuating cycle and risk of physical inactivity[5].

The musculoskeletal impact of obesity is increasingly apparent in Pakistan, but the degree has not been well explored. Lahore study, which has been done to assess generalized joint hypermobility (GJH) and its association with osteoarthritis in young and middle-aged women, found that 67.24 % of the subjects had hypermobility at multiple joint sites and hence had an increased risk of joint instability and subsequent osteoarthritic changes[6]. Even so, not much is known about how the structural and functional implications of obesity affect joint health in the Pakistani population. Additionally, obesity is a known risk factor for osteoarthritis, but the contribution of obesity to other joint disorders, such as patellofemoral pain syndrome and lumbar spine dysfunction in the local population, is not well studied[7].

The purpose of this study was to fill this gap by evaluating the anatomical and functional consequences of obesity on joint health in adults in Lahore, Pakistan. The study determined the extent to which obesity contributes to joint degeneration and functional impairment by employing radiographic imaging, mobility assessments, and standardized clinical evaluations. To best prevent and manage obesity-related musculoskeletal conditions, it is important to understand the relationship between obesity and joint pathology[8]. The results of this study have important implications for public health policy since it emphasizes the importance of early management of weight, lifestyle changes, and tailoring rehabilitation programs to mitigate the impact of obesity on joint health. As obesity is becoming increasingly prevalent in Pakistan, it should be a priority in preventive and therapeutic

healthcare strategies to address the musculoskeletal consequences of obesity.

MATERIALS AND METHODS

Study Design and Setting: A cross-sectional study was conducted at different tertiary healthcare centres in Lahore, Pakistan, from December 2021 to December 2022. They selected these hospitals because of their expertise in musculoskeletal health and obesity-related disorders. The study was conducted with the approval of the Institutional Review Board (IRB), and written informed consent was obtained from all participants before participation in the study. Participants were recruited in compliance with ethical guidelines and allowed to remain anonymous and volunteer.

Study Population and Sample Size: There were 150 participants aged between 30 and 60 years for the study. Depending on their BMI, participants were categorized into two groups. The subjects in the non-obese group had a BMI of less than 25 kg/m² (n=75), and the subjects in the obese group had a BMI of equal to or greater than 30 kg/m² (n=75). Selected hospitals' outpatient departments recruited participants with equal numbers of both genders for balanced analysis. Demographic data, medical history, and lifestyle factors were obtained using a structured questionnaire to avoid confounding by relevant covariates.

Inclusion and Exclusion Criteria: Adults aged 30 to 60 years with a BMI within the defined ranges for obese and nonobese groups were included as inclusion criteria for this study. To avoid excluding participants with previous experience with joint replacement surgery, participants with diagnosed autoimmune diseases affecting joint function and those unwilling to undergo clinical and radiographic evaluation were excluded.

Individuals with a history of inflammatory arthritis (such as rheumatoid arthritis or gout), congenital joint deformities, previous traumatic joint injuries, chronic steroid therapy, or immunosuppressive medications were excluded. Furthermore, patients with malignancies or other musculoskeletal disorders not related to obesity were excluded to limit the study findings to the effects of obesity on joint integrity and mobility.

Anthropometric and Clinical Assessments: Anthropometric measurements of all participants were carried out using calibrated digital instruments and included height, weight, and BMI. Central obesity was also assessed with waist-to-hip ratio. The joint pain and stiffness and the functional impairments were assessed via a comprehensive musculoskeletal examination. The clinical evaluation included tenderness, crepitus, swelling, and posture abnormalities.

Radiographic and Imaging Assessments: All participants underwent standard radiographic imaging of the knee, hip, and ankle joints to assess structural changes such as joint space narrowing, osteophyte formation, and subchondral sclerosis. Thirty participants (15 from each group) were then imaged using Magnetic Resonance Imaging (MRI) to measure cartilage integrity, synovial inflammation, and early degenerative changes that are not visible in standard X-rays. The BMI classification of the participants was blinded to the radiologists who interpreted all imaging assessments.

Joint Mobility Assessment: The ROM of the knee, hip, and ankle joints was assessed using a standardized goniometer. Knee flexion, hip abduction, and ankle dorsiflexion (mobility parameters) were measured as the main mobility parameters. The ROM was recorded in degrees and categorized as mild, moderate, or severe limitations as defined in established clinical guidelines. All the assessments were performed by trained physiotherapists to ensure consistency and accuracy.

Pain and Functional Limitation Assessment: WOMAC was used to evaluate pain and functional limitations. WOMAC scores were used to measure pain, stiffness, and physical function on a standardized scale where higher scores indicated greater pain and reduced joint function. Participants' symptoms were self-reported using the WOMAC questionnaire, and functional impairments were additionally validated through physical performance tests, including a timed up-and-go test and a minute walk test.

Statistical Analysis: SPSS version 26 was used to conduct all statistical analyses. Demographic and clinical characteristics of participants were summarized with descriptive statistics. Continuous variables like joint mobility and pain scores were compared between the two groups by applying independent t-tests. Categorical variables were analyzed with chi-square tests, including the presence of joint space narrowing and osteophyte formation. Statistically significant was determined to be a p-value less than 0.05. An independent statistician was used to review and cross-check the collected data for reliability and accuracy.

RESULTS

Demographic and Clinical Characteristics: Ninety patients were included in the obese group (n=75) and 60 in the nonobese group (n=75). Participants in the nonobese group were 45.3 years of age, and in the obese group, 46.1 years of age, but the difference was not statistically significant ($p = 0.58$). The BMI of the obese group was significantly higher than that of the nonobese group (32.6 kg/m² vs. 23.2 kg/m², $p < 0.001$).

For the nonobese group, gender distribution was 50 % males and 50 % females, same for the obese group, 48 % males and 52 % females, where no significant difference was found ($p = 0.68$).

Table 1: Updated Demographic Characteristics of Study Participants

Characteristic	Non-Obese (n=75)	Obese (n=75)	p-Value
Age (years)	45.3 ± 8.2	46.1 ± 7.9	0.58
BMI (kg/m²)	23.2 ± 1.9	32.6 ± 2.5	<0.001
Female (%)	50%	52%	0.72
Male (%)	50%	48%	0.68

Joint Integrity Findings: Obese participants also had a significantly greater prevalence of joint space narrowing, osteophyte formation, and subchondral sclerosis on radiographic assessment compared with nonobese participants. Obese individuals were identified to have joint space narrowing in 60% compared with 15% of the nonobese group ($p < 0.001$). Obese participants formed more osteophytes (68%) compared to nonobese (20%, $p < 0.001$). Moreover, subchondral sclerosis was present in 55% of the obese individuals in contrast to 10% in the non-obese group ($p < 0.001$), suggesting a strong correlation of obesity with joint degeneration.

Table 2: Joint Integrity Findings from Radiographic Assessments

Parameter	Non-Obese (n=75)	Obese (n=75)	p-Value
Joint Space Narrowing	15%	60%	<0.001
Osteophyte Formation	20%	68%	<0.001
Subchondral Sclerosis	10%	55%	<0.001

Joint Mobility Assessment: Joint mobility also reduced significantly in obese participants who experienced the most reduction in joint mobility in knee flexion, hip abduction, and ankle dorsiflexion. The mean knee flexion in the obese group was 110° ± 10, significantly lower than 135° ± 8 in the nonobese group, an 18 % lower ($p < 0.01$). Obese subjects had reduced hip abduction (22%, 35° ± 6 vs. 45° ± 5, $p < 0.01$) and ankle dorsiflexion (25%, 15° ± 4 vs. 20° ± 3, $p < 0.01$).

Table 3: Joint Mobility Assessment

Joint Movement	Non-Obese ROM (Mean ± SD)	Obese ROM (Mean ± SD)	Reduction (%)	p-Value
Knee Flexion	135 ± 8	110 ± 10	18%	<0.01
Hip Abduction	45 ± 5	35 ± 6	22%	<0.01
Ankle Dorsiflexion	20 ± 3	15 ± 4	25%	<0.01

Pain and Functional Limitation Assessment (WOMAC Scores): Obese patients were found to have significantly greater pain and

functional impairment on the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Notably, the mean pain score in the obese group was 6.8 ± 1.5 vs. 3.2 ± 1.1 in the nonobese group ($p < 0.001$). The stiffness scores among participants who were obese were significantly higher (5.3 ± 1.2 vs. 2.0 ± 0.8, $p < 0.001$). Obese individuals had significantly higher (15.3 ± 3.6 vs. 8.1 ± 2.4, $p < 0.001$) functionality scores, that is, more severe limitations of daily activities.

Table 4: WOMAC Pain and Function Scores

Category	Non-Obese (Mean ± SD)	Obese (Mean ± SD)	p-Value
Pain Score	3.2 ± 1.1	6.8 ± 1.5	<0.001
Stiffness Score	2.0 ± 0.8	5.3 ± 1.2	<0.001
Functionality Score	8.1 ± 2.4	15.3 ± 3.6	<0.001

This study finds that obesity has a major influence on joint health, mobility, and pain levels in both males and females. Marked joint degeneration was observed in obese individuals with significantly higher rates of joint space narrowing, osteophyte formation, and subchondral sclerosis ($p < 0.001$), suggestive of progressive joint deterioration.

Obese individuals were significantly less mobile, with significant reductions in knee flexion (18% decrease), hip abduction (22% decrease), and ankle dorsiflexion (25% decrease, $p < 0.01$). The fact that obesity contributes to both accelerated joint degeneration and severe mobility limitations and chronic pain is indicated by this decline in mobility, accompanied by higher WOMAC pain, stiffness, and functionality scores.

Overall, this study provides strong evidence that obesity plays an important role in joint deterioration and functional impairment in both men and women. The results underline the necessity of early intervention strategies, such as weight management programs, physiotherapy, and lifestyle modifications to avert obesity-associated musculoskeletal complications in the Pakistani population. Since this study has a balanced gender representation, the findings indicate that the effects of obesity on joint health are as harmful for males as for females, and further research should be done to identify gender-specific treatment options.

DISCUSSION

As a result of this study, compelling evidence presents the adverse effects of obesity on the joint integrity and mobility of adults in Pakistan. It was found that obese individuals had significantly more joint degeneration with a higher prevalence of joint space narrowing, osteophyte formation, and subchondral sclerosis ($p < 0.001$). These structural changes fit with previous global studies that have found this kind of obesity is linked to higher mechanical stress and systemic inflammation, both of which lead to cartilage degradation and joint dysfunction[9]. The results of this study further support the mechanical overload hypothesis in which increased body weight leads to abnormal joint loading, increased wear and tear, and development of osteoarthritic changes, especially in weight-bearing joints such as the knees and hips[10].

In addition, joint mobility was significantly impaired for obese participants. Knee flexion, hip abduction, and ankle dorsiflexion were significantly reduced ($p < 0.01$), with obese individuals having a range of motion (ROM) reduction of 18–25%. Both mechanical limitations caused by excessive adipose tissue surrounding the joints and chronic inflammation-induced changes in joint biomechanics are likely to lead to restriction of joint mobility[11]. The observed ROM impairments are especially concerning because they not only reduce physical activity but also increase the likelihood of gaining more weight, which in turn leads to further musculoskeletal decline and obesity[12].

The obese group also had significantly worse pain and functional disability, as measured by the WOMAC index ($p < 0.001$), higher pain, stiffness, and functional impairment scores. In other words, obesity not only affects joint structure and mobility, but the quality of life is also greatly affected, and it becomes increasingly difficult to do everyday things such as walking, climbing stairs, and standing for long periods[13]. Previously, obesity has been associated with chronic low-grade inflammation as a result of increased levels of adipokines (leptin, resistin, and adiponectin) and proinflammatory cytokines (IL6 and TNF α) that may lead to increased pain perception and additional impairment of joint function[14].

Furthermore, this study also shows gender-balanced findings in which both males and females suffer the same extent of joint deterioration and mobility restriction. If joint impairment is universally detrimental, regardless of sex, then there was very little difference in the gender distribution of impairment. The importance of targeted interventions to address weight management and joint health for men and women is underlined[15, 16].

Hence, the findings of this study have regional relevance as compared to previous studies conducted in Western populations that have primarily attributed obesity to osteoarthritis progression and increased knee replacement rates. These results are critical in terms of providing evidence for the need for culturally tailored preventive and therapeutic strategies for the high prevalence of obesity and the rising disease burden of musculoskeletal diseases in Pakistan[17].

The study's cross-sectional design, however, does not enable determining a causal relationship between obesity and joint degeneration. Progressive changes in joint structure over time and long-term effects of weight loss interventions should be assessed via longitudinal studies. Furthermore, the incorporation of biochemical markers of inflammation and metabolic dysfunction in this study would have provided a more mechanistic understanding of obesity-driven joint deterioration[18, 19].

CONCLUSION

This study confirms that obesity greatly impacts joint integrity, mobility, and function, increasing joint degeneration, restricted movement, and pain. These musculoskeletal impairments are caused both by mechanical overload and chronic inflammation, which implies that early weight management and targeted interventions are needed.

With the increasing obesity rates in Pakistan, it becomes a need to carry out physiotherapy, structured exercise programs, and nutritional counselling to avoid obesity-related joint complications. Maintaining a healthy weight is important for public health initiatives to preserve joint health.

Future research should investigate the long-term effect of weight loss interventions on joint health and develop a multidisciplinary approach with orthopedic specialists, physiotherapists, and metabolic health experts. Early attention to obesity will reduce musculoskeletal disease burden and improve quality of life in those individuals affected.

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