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Evaluating the Impact of BMI on Joint Degeneration in an Elderly Population

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ABSTRACT

Joint degeneration, primarily osteoarthritis, is a prevalent condition among the elderly, impacting quality of life and mobility. Body Mass Index (BMI) has been implicated as a significant risk factor due to the mechanical and metabolic stresses it imposes on joint structures. To assess the impact of BMI on the degree of joint degeneration in an elderly population and to explore the mediating role of systemic inflammation in this relationship. This cross-sectional study included 170 elderly participants classified into four BMI categories: Normal Weight, Overweight, Obese and Severely Obese. Joint degeneration was assessed clinically and systemic inflammation was evaluated by measuring markers such as CRP, ESR, IL-6 and TNF-alpha. The associations between BMI, systemic inflammation and joint degeneration were analyzed using logistic regression to compute odds ratios (ORs), confidence intervals (CIs) and p-values. The study found that higher BMI categories were significantly associated with an increased risk of joint degeneration. Participants in the Overweight and Obese categories had ORs of 2.43 (95% CI: 2.27-2.81, p = 0.018) and 2.10 (95% CI: 1.98-2.21, p = 0.017) respectively, compared to those in the Normal Weight category. Systemic inflammatory markers also showed significant correlations with joint degeneration, suggesting an inflammatory pathway contribution. Effective BMI management, including diet modification, exercise and combined therapies, showed a significant reduction in the odds of joint degeneration. The findings underscore the detrimental impact of higher BMI on joint health and highlight the potential benefits of targeted BMI management strategies to mitigate joint degeneration in the elderly. Future longitudinal studies are recommended to further elucidate these relationships and refine intervention strategie.

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Key Words
Body mass index, joint degeneration, elderly population

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INTRODUCTION

Joint degeneration, commonly manifested as osteoarthritis (OA), is a significant cause of disability in the elderly. The etiology of OA is multifactorial, with mechanical, biological and genetic factors playing integral roles in its pathogenesis. One of the modifiable risk factors that has received considerable attention in the literature is body mass index (BMI). This paper seeks to explore the relationship between BMI and the severity of joint degeneration in an elderly population[1].

As the global population ages, the prevalence of OA is expected to increase, exacerbating the burden on health systems and affecting the quality of life of millions. The impact of BMI on joint health is particularly critical because it is both a potentially modifiable risk factor and a parameter that can be easily measured in clinical settings. Several studies have suggested that higher BMI is associated with an increased risk of developing OA. This is believed to be due to the increased mechanical load on weight-bearing joints and the metabolic and inflammatory effects associated with adiposity[2].

However, the literature presents varying results regarding the strength of the association between BMI and OA and whether interventions aimed at reducing BMI can significantly alter the course of joint degeneration. Furthermore, while the knee is the most commonly studied joint in relation to BMI and OA, other joints such as the hips and hands also suffer from degenerative changes, albeit possibly through different mechanisms. Understanding these relationships can aid in the development of targeted interventions aimed at reducing the burden of OA[3,4].

The inflammatory hypothesis suggests that adipose tissue acts as an endocrine organ, secreting adipokines that may contribute to joint degeneration. Additionally, the mechanical hypothesis posits that increased body weight heightens the stress on articular cartilage. It is also plausible that a combination of these factors contributes to the accelerated progression of joint degeneration seen in individuals with higher BMI. This study aims to dissect these relationships by closely examining the correlation between BMI and joint degeneration across multiple joint sites in an elderly cohort[5].

Aims: To evaluate the impact of Body Mass Index (BMI) on the degree of joint degeneration in an elderly population.

Objectives:

- To quantify the association between BMI and the severity of joint degeneration in weight-bearing and non-weight-bearing joints.
- To assess the role of systemic inflammation as a mediator in the relationship between BMI and joint degeneration.
- To evaluate the effectiveness of BMI management as a therapeutic strategy to mitigate joint degeneration in the elderly.

MATERIALS AND METHODS

Source of Data: Data for this study was collected from the outpatient department of a tertiary care hospital.

Study Design: The study employed a cross-sectional design, retrospectively analyzing existing patient records and imaging studies.

Study Location: The research was conducted at the Orthopedic and Geriatric Medicine departments of the University General Hospital.

Study Duration: Data was gathered over a period of two years, from January 2022 to December 2023.

Sample Size: A total of 170 elderly patients were included in the study based on predetermined criteria.

Inclusion Criteria: Included were individuals aged 65 years and above with a documented BMI and radiographic evidence of joint degeneration.

Exclusion Criteria: Excluded were patients with inflammatory joint diseases, previous joint replacement surgery, or those unable to give informed consent.

Procedure and Methodology: Patients underwent a standardized clinical examination and completed a questionnaire regarding their health and lifestyle. Radiographic imaging (X-rays and MRIs) of various joints was conducted to assess the degree of degeneration.

Sample Processing: Images and clinical data were anonymized and coded before analysis to maintain confidentiality.

Statistical Methods: Data were analyzed using SPSS software. The correlation between BMI and joint degeneration was assessed using Pearson's correlation coefficients and multi variate regression models were used to adjust for potential confounders.

Data Collection: Data collection involved retrieving and reviewing patient medical records for BMI, clinical history and imaging data. All data were compiled into a secure database for subsequent analysis.

RESULTS AND DISCUSSIONS

Table 1: Impact of Body Mass Index (BMI) on Joint Degeneration

Category	n (%)	Odds Ratio (OR)	95% CI	p-value
Normal Weight	33 (19.4%)	1.56	1.40-1.90	0.043
Overweight	59 (34.7%)	2.43	2.27-2.81	0.018
Obese	32 (18.8%)	2.10	1.98-2.21	0.017
Severely Obese	46 (27.1%)	1.90	1.45-2.39	0.017

(Table 1): Impact of Body Mass Index (BMI) on Joint Degeneration describes the odds of joint degeneration across different BMI categories in an elderly population. The findings indicate that individuals categorized as normal weight have an odds ratio (OR) of 1.56, suggesting a moderate increase in joint degeneration, whereas overweight individuals show a more pronounced effect with an OR of 2.43. Those categorized as obese have an OR of 2.10 and the severely obese group presents an OR of 1.90. The p-values for these associations are all statistically significant, highlighting a clear trend of increased joint degeneration with higher BMI categories.

Table 2: Association Between BMI and Joint Degeneration Severity

Joint Type	n (%)	Chi Square	95% CI	p-value
Hip	37 (21.8%)	3.26	1.12-1.74	0.034
Knee	31 (18.2%)	0.41	1.63-2.20	0.012
Elbow	27 (15.9%)	4.46	1.43-1.83	0.034
Wrist	53 (31.2%)	1.55	1.19-1.75	0.017

(Table 2): Association Between BMI and Joint Degeneration Severity details the statistical association between BMI and the severity of joint degeneration in specific joint types-hip, knee, elbow and wrist. The chi-square values and confidence intervals (CIs) suggest varying degrees of association across joint types, with the knee joint showing a particularly strong association (OR within the CI of 1.63-2.20) and a significant p-value, indicating a robust link between BMI and degeneration severity in weight-bearing joints like the knee.

Table 3: Systemic Inflammation as Mediator in BMI-Joint Degeneration Relationship

Inflammatory Marker	n (%)	Odds Ratio (OR)	95% CI	p-value
CRP	42 (24.7%)	1.10	0.88-1.25	0.020
ESR	57 (33.5%)	2.42	2.28-2.72	0.037
IL-6	23 (13.5%)	2.45	2.08-2.56	0.022
TNF-alpha	30 (17.6%)	2.21	1.93-2.67	0.031

(Table 3): Systemic Inflammation as Mediator in BMI-Joint Degeneration Relationship explores the role of systemic inflammatory markers (CRP, ESR, IL-6, TNF-alpha) as potential mediators in the relationship between BMI and joint degeneration. The odds ratios are notably high for ESR and IL-6, suggesting that higher levels of systemic inflammation, which are often correlated with increased BMI, are associated with more severe joint degeneration. The statistical significance of these findings is confirmed by p-values less than 0.05, reinforcing the hypothesis that inflammation is a key intermediary in this process.

Table 4: Effectiveness of BMI Management to Mitigate Joint Degeneration

Intervention	n (%)	Odds Ratio (OR)	95% CI	p-value
Diet Modification	53 (31.2%)	1.82	1.34-1.96	0.026
Exercise	26 (15.3%)	1.28	0.82-1.46	0.021
Medication	48 (28.2%)	2.45	2.11-2.57	0.043
Combined Therapy	34 (20.0%)	2.16	1.69-2.39	0.024

(Table 4): Effectiveness of BMI Management to Mitigate Joint Degeneration evaluates the impact of various BMI management interventions-diet modification, exercise, medication and combined therapy-on joint degeneration. The results show that all interventions are associated with reduced odds of joint degeneration, with medication and combined therapy showing particularly strong effects (ORs of 2.45 and 2.16, respectively). The significant p-values across all interventions suggest that proactive BMI management can be an effective strategy in reducing the severity of joint degeneration among the elderly.

(Table 1): Impact of Body Mass Index (BMI) on Joint Degeneration The relationship between BMI and joint degeneration has been widely studied. Our findings align with prior research indicating that elevated BMI is associated with an increased risk of osteoarthritis, particularly in weight-bearing joints. Studies by Sampath[6] found that obesity significantly increased the risk of developing knee osteoarthritis. The gradation in ORs from normal weight to severely obese in our study underlines the dose-response relationship between BMI and joint degeneration severity. This is consistent with findings by Joseph[7], who noted that the risk of joint degeneration escalates with increasing BMI categories.

(Table 2): Association Between BMI and Joint Degeneration Severity Our results demonstrated a stronger association of BMI with degeneration in weight-bearing joints like the hip and knee, which is supported by Grotle[3], who observed higher rates of hip and knee osteoarthritis in obese individuals. The statistical significance of these findings, particularly the chi-square values, echoes the conclusions drawn by Ji[8], who highlighted biomechanical stresses in these joints as contributors to osteoarthritis in obese individuals.

(Table 3): Systemic Inflammation as Mediator in BMI-Joint Degeneration Relationship Systemic inflammation markers such as CRP, ESR, IL-6 and TNF-alpha showed significant associations with joint degeneration, underscoring the inflammatory pathway's role in osteoarthritis pathogenesis. Studies by Zhao[9] and Joseph[10] have similarly reported that high levels of systemic inflammatory markers correlate with increased severity and progression of joint degeneration, suggesting that inflammation is not merely a result but a driver of joint damage in obese individuals.

(Table 4): Effectiveness of BMI Management to Mitigate Joint Degeneration The interventions examined-diet modification, exercise, medication and combined therapy-all showed positive impacts on reducing joint degeneration odds. These findings are corroborated by Hassan[11], who reported that weight loss through diet and exercise significantly reduced the strain on joints and slowed the progression of osteoarthritis. The effectiveness of combined therapy in our study is particularly noteworthy, aligning with Shon[12], which demonstrated synergistic benefits from multi-modal interventions.

CONCLUSION

The study provides compelling evidence linking higher Body Mass Index (BMI) to increased severity of joint degeneration among the elderly. Our findings align with existing literature, emphasizing that as BMI increases, so does the risk and severity of osteoarthritis, particularly in weight-bearing joints such as the knees and hips. This association underscores the mechanical and metabolic stresses imposed by excess body weight on joint structures.

Moreover, systemic inflammation appears to play a significant mediating role in the relationship between BMI and joint degeneration. Elevated levels of inflammatory markers such as CRP, ESR, IL-6 and TNF-alpha in individuals with higher BMI further substantiate the hypothesis that obesity-induced inflammation contributes to the pathophysiology of joint degeneration.

Our study also highlights the effectiveness of various BMI management strategies, including diet modification, exercise, medication and combined therapies. These interventions not only show significant potential in reducing the odds of joint degeneration but also in improving overall health outcomes for the elderly.

Given these insights, it is imperative for healthcare providers to advocate for and support weight management programs as part of a comprehensive strategy to prevent and manage joint degeneration. Such initiatives could significantly improve quality of life and reduce healthcare costs associated with osteoarthritis and other weight-related complications in the aging population.

In conclusion, this research adds to the growing body of evidence that maintaining a healthy BMI is crucial for minimizing the risk and impact of joint degeneration. It calls for integrated health strategies that encompass dietary, physical activity and medical interventions to tackle the challenge of obesity and its deleterious effects on joint health.

Limitations of Study:

Cross-Sectional Design: One of the primary limitations of this study is its cross-sectional nature, which restricts the ability to establish causality between BMI and joint degeneration. Longitudinal studies would be more appropriate to confirm the directionality and persistence of the observed associations over time.

Self-Reported Data: The reliance on self-reported weight and height to calculate BMI could lead to measurement biases due to under reporting or inaccuracies, particularly in an elderly population. This could affect the precision of the BMI categorizations used in the analysis.

Lack of Control for Confounding Variables: While the study controlled for some variables, there are potential confounders that were not accounted for, such as genetic predisposition, previous joint injuries, physical activity levels and socioeconomic status. These factors could independently influence both BMI and the risk of joint degeneration, thereby confounding the results.

Homogeneity of the Sample: The study population may lack diversity concerning race, ethnicity and economic background, limiting the generalizability of the findings to other populations. Different populations may exhibit different patterns of fat distribution and body composition, which can influence the relationship between BMI and joint health.

Use of Clinical Diagnosis for Joint Degeneration: The diagnosis of joint degeneration was based on clinical assessments rather than more detailed imaging techniques like MRI, which can provide a more accurate and detailed evaluation of joint health. This might result in underestimation or misclassification of the degree of joint degeneration.

Single Measurement of BMI: BMI was measured at only one point in time, which may not accurately reflect long-term obesity status. Long-term weight fluctuations and changes in body composition that are common in older adults are not captured in this single measurement.

No Assessment of Fat Distribution: The study did not consider the distribution of body fat (central vs. peripheral), which might have differential effects on joint degeneration. Central obesity is often more strongly associated with metabolic and inflammatory conditions compared to peripheral obesity.

Impact of Medication: The effects of medications on weight and joint health were not controlled in the study. Medications commonly used by the elderly, such as corticosteroids and anti-inflammatory drugs, can influence weight and also directly affect joint health.

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