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Original Article

Association Between Body Mass Index and Anterior Knee Pain–Related Function in Physically Inactive Young Adults: A Cross-Sectional Study

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ABSTRACT

Background: Anterior knee pain is a common musculoskeletal complaint in young adults and may be influenced by body mass index and physical inactivity. Excess body weight can increase patellofemoral loading and may worsen pain-related functional limitation. Objective: To compare anterior knee pain-related function between physically inactive young adults with normal BMI and increased BMI. Methods: This cross-sectional study included 377 physically inactive young adults aged 17–35 years from universities in Sialkot, Pakistan. Physical activity was assessed using the International Physical Activity Questionnaire, and only participants with low activity levels, defined as <600 MET-min/week, were included. BMI was calculated from height and weight, and anterior knee pain-related function was assessed using the Kujala Anterior Knee Pain Scale. Normality was assessed using the Shapiro–Wilk test, and between-group comparison was performed using the Mann–Whitney U test. Results: Of 377 participants, 186 had normal BMI and 191 had increased BMI. The mean age was 25.46 ± 4.73 years, mean BMI was 24.41 ± 3.43 kg/m², and mean Kujala score was 75.60 ± 24.81. Kujala scores differed significantly between BMI groups, with higher mean ranks in the normal-BMI group than the increased-BMI group (237.24 vs. 139.33; U = 8327.00, Z = -8.813, $p < 0.001$; r = 0.45). Conclusion: Increased BMI was significantly associated with poorer anterior knee pain-related function among physically inactive young adults. Keywords: Anterior knee pain syndrome; body mass index; Kujala score; physical inactivity; young adults.

INTRODUCTION

Anterior knee pain is a common musculoskeletal complaint in adolescents and young adults and is frequently described as pain localized around or behind the patella, particularly during activities that increase patellofemoral joint loading, such as stair climbing, squatting, jumping, running, prolonged sitting with flexed knees, and kneeling. It is often discussed under overlapping clinical terms, including anterior knee pain, patellofemoral pain syndrome, and anterior knee pain syndrome; however, in this study, the term anterior knee pain syndrome refers to anterior knee pain-related symptoms and functional limitation measured through the Kujala Anterior Knee Pain Scale rather than a radiologically confirmed structural knee diagnosis. Anterior knee pain has been reported across athletic and non-athletic populations and may interfere with daily function, participation in physical activity, and long-term musculoskeletal health, particularly when symptoms begin during adolescence or early adulthood (1,2).

Although anterior knee pain is commonly associated with sports participation and repetitive loading, emerging evidence suggests that it is also clinically relevant among sedentary or physically inactive young adults. Physical inactivity may contribute to poor muscular conditioning, reduced flexibility, impaired neuromuscular control, and weakness of the quadriceps and hip musculature, all of which can adversely affect patellofemoral joint mechanics. At the same time, excess body weight may increase mechanical demand across the knee joint and may contribute to pain and functional limitation through increased patellofemoral loading, altered lower-limb biomechanics, and obesity-related inflammatory mechanisms (3,4). Body mass index remains a practical and widely used anthropometric measure for classifying body weight status, and its relationship with knee pain is particularly important in young adults because weight-related musculoskeletal symptoms during this life stage may discourage physical activity and promote long-term sedentary behavior (5,6).

Previous studies have shown that individuals with patellofemoral pain may have higher BMI and poorer functional capacity than pain-free controls, and overweight or obesity has been associated with reduced knee-related function and worse clinical outcomes (7). However, the relationship between BMI and anterior knee pain-related function is still insufficiently explored in physically inactive university-aged populations, especially in local educational settings where sedentary academic routines, weight gain, and limited structured exercise may coexist. Many available studies focus on athletes, military recruits, or clinically diagnosed populations, while fewer studies compare anterior knee pain-related functional status between normal-weight and overweight young adults who are similarly inactive. This distinction is important because physical inactivity itself may influence knee symptoms; therefore, comparing BMI groups within a physically inactive sample may help clarify whether overweight participants demonstrate poorer knee-related function even when activity level is consistently low across groups.

The present study was therefore conducted to compare anterior knee pain-related symptoms and functional limitation between physically inactive young adults with normal BMI and those with increased BMI attending universities in Sialkot, Pakistan. The study specifically used the Kujala Anterior Knee Pain Scale to assess knee pain-related function and the International Physical Activity Questionnaire to confirm low physical activity status. The objective of this study was to determine whether Kujala scores differ significantly between normal-BMI and overweight/increased-BMI young adults who are physically inactive. It was hypothesized that physically inactive young adults with higher BMI would demonstrate lower Kujala scores, indicating poorer knee-related function and greater anterior knee pain-related limitation.

MATERIALS AND METHODS

This observational cross-sectional study was conducted among physically inactive young adults enrolled in government and private universities in Sialkot, Pakistan. Data were collected over a six-month period after synopsis approval. The study was designed to compare anterior knee pain-related function between BMI-based groups at a single point in time, without assigning any intervention or follow-up exposure. The target population consisted of university students and young adults from multiple academic departments, including Law, Computer Science, Fashion Design, and Information Technology, to improve representation across non-clinical academic disciplines.

A purposive sampling technique was used to recruit participants who met the eligibility criteria. Participants were included if they were aged 17–35 years, belonged to either gender, provided informed consent, and were classified as physically inactive according to the International Physical Activity Questionnaire, with total activity below 600 MET-minutes/week. Participants were excluded if they were pregnant; had rheumatoid arthritis affecting the knee; reported a previous history of knee trauma, fracture, or knee surgery; or had any condition that could independently explain knee pain and confound assessment of anterior knee pain-related function. Written informed consent was obtained before data

collection, and participants were informed about the study purpose, voluntary participation, and confidentiality of their responses.

The sample size was 377 participants, calculated using the WHO sample size calculator with a 95% confidence level and 5% margin of error. Demographic and anthropometric data, including age, gender, height, and weight, were recorded through face-to-face assessment. Body mass index was calculated as weight in kilograms divided by height in meters squared. Participants were categorized according to standard BMI criteria, with normal BMI defined as 18.5–24.9 kg/m² and increased BMI including participants above the normal range. Because the recorded BMI range extended up to 38.60 kg/m², participants with BMI ≥25 kg/m² should be reported as an increased-BMI group rather than strictly as "overweight" unless obese participants are separated or excluded during final data verification. This correction is necessary to maintain consistency between BMI classification and the reported descriptive range.

Physical activity level was assessed using the International Physical Activity Questionnaire, which estimates activity during the previous seven days and expresses total activity as metabolic equivalent task minutes per week. Only participants with low physical activity, defined as less than 600 MET-minutes/week, were retained in the analysis. Anterior knee pain-related function was assessed using the Kujala Anterior Knee Pain Scale, a 13-item questionnaire evaluating pain and functional limitation during activities relevant to patellofemoral loading. The total Kujala score ranges from 0 to 100, with higher scores indicating better knee-related function and fewer anterior knee pain-related symptoms.

To reduce information bias, all questionnaires were administered face-to-face by the researcher using consistent instructions. Participants were allowed to ask clarification questions during completion, and responses were checked at the time of collection to minimize missing data. Selection bias was addressed partly by recruiting from multiple university departments; however, because purposive sampling was used, generalizability remains limited to similar physically inactive young adult university populations. Potential confounding variables included age, gender, BMI category, and physical activity level. Since the primary comparison was between BMI groups within a physically inactive sample, physical inactivity was controlled at the eligibility stage by including only participants below 600 MET-minutes/week.

Data were entered and analyzed using SPSS version 26.0. Descriptive statistics were calculated for age, BMI, MET-minutes/week, and Kujala scores using mean, standard deviation, minimum, and maximum values where appropriate, while categorical variables were summarized as frequencies and percentages. The distribution of Kujala scores was assessed using the Shapiro–Wilk test. Because Kujala scores were not normally distributed, between-group comparison was performed using the Mann–Whitney U test. Median and interquartile range should be reported alongside mean ranks for each BMI group, and the exact p-value should be reported as $p < 0.001$ where applicable rather than $p = .000$. Effect size, preferably rank-biserial correlation or r derived from the Mann–Whitney Z statistic, should be added to strengthen interpretation of the between-group difference. Statistical significance was set at $p < 0.05$. No missing questionnaire data were reported because face-to-face verification was completed during data collection.

Ethical approval was obtained before commencement of the study, and all procedures were conducted in accordance with ethical principles for research involving human participants. Participant confidentiality was maintained by using collected data only for research purposes. Data integrity was supported through direct questionnaire checking, standardized scoring procedures, and analysis using a predefined statistical plan.

RESULTS

A total of 377 physically inactive young adults were included. The mean age was 25.46 ± 4.73 years, ranging from 17 to 35 years. The mean BMI was 24.41 ± 3.43 kg/m², with values ranging from 18.50 to 38.60 kg/m². Because the BMI maximum exceeded the overweight range, participants with BMI ≥25

kg/m² were classified as the increased-BMI group rather than strictly as overweight. IPAQ-based activity levels confirmed low physical activity, with MET values ranging from 100 to 580 MET-min/week and a mean of 320.00 ± 213.54 MET-min/week. The overall Kujala score ranged from 14 to 100, with a mean score of 75.60 ± 24.81, indicating mild-to-moderate anterior knee pain-related functional limitation in the overall sample.

Table 1. Participant Characteristics

Variable	N	Minimum	Maximum	Mean ± SD
Age, years	377	17	35	25.46 ± 4.73
Body mass index, kg/m²	377	18.50	38.60	24.41 ± 3.43
MET total, min/week	377	100.00	580.00	320.00 ± 213.54
Kujala total score	377	14.00	100.00	75.60 ± 24.81

Based on BMI classification, 186 participants were in the normal-BMI group and 191 were in the increased-BMI group, representing 49.3% and 50.7% of the sample, respectively.

Table 2. BMI Group Distribution

BMI Category	Frequency	Percent
Normal BMI	186	49.3
Increased BMI	191	50.7
Total	377	100.0

The Shapiro–Wilk test showed that Kujala scores were not normally distributed in either BMI group. Therefore, non-parametric testing was applied.

Table 3. Normality Testing for Kujala Scores

BMI Group	Shapiro–Wilk Statistic	df	p-value
Normal BMI	0.784	185	<0.001
Increased BMI	0.927	190	<0.001

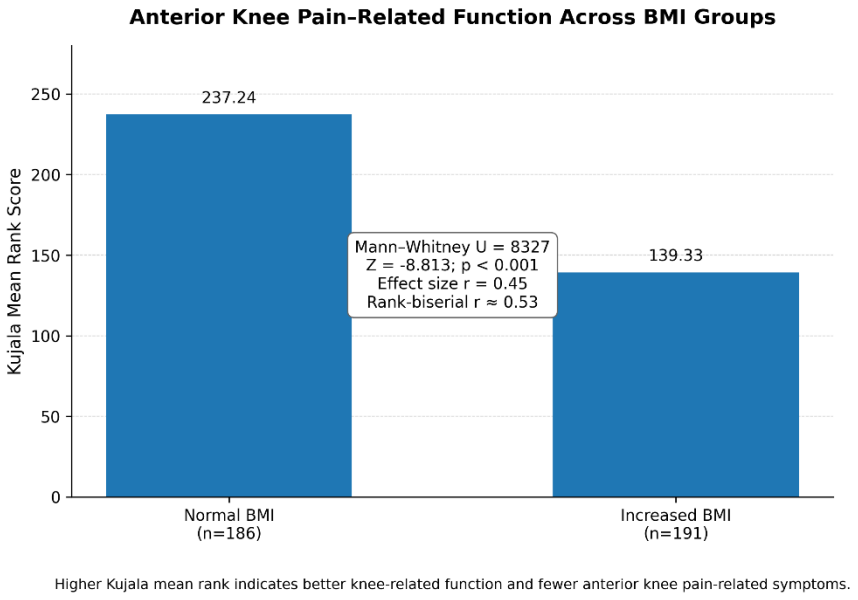

Figure 1 Anterior Knee Pain–Related Function Across BMI Groups

The Mann–Whitney U test showed a statistically significant difference in Kujala scores between BMI groups. Participants with normal BMI had a higher mean rank than participants with increased BMI, indicating better knee-related function and fewer anterior knee pain-related symptoms. The effect size calculated from the Z statistic was moderate-to-large (r = 0.45), while the rank-biserial correlation was approximately 0.53, indicating a meaningful difference between groups.

Table 4. Comparison of Kujala Scores Between BMI Groups

BMI Group	N	Mean Rank	Sum of Ranks	Mann–Whitney U	Z	p-value	Effect Size
Normal BMI	186	237.24	43653.00	8327.00	-8.813	<0.001	r = 0.45
Increased BMI	191	139.33	26472.00	—	—	—	Rank-biserial r ≈ 0.53

These findings demonstrate that physically inactive young adults with increased BMI had significantly poorer anterior knee pain-related function than those with normal BMI. The magnitude of the difference was not only statistically significant but also clinically meaningful, suggesting that elevated BMI is associated with greater functional limitation in this population.

Figure 1 showed normal-BMI participants had markedly higher Kujala mean rank scores than increased-BMI participants (237.24 vs. 139.33), indicating better knee-related function and fewer anterior knee pain-related symptoms. The difference was statistically significant and clinically meaningful (Mann–Whitney U = 8327, Z = -8.813, $p < 0.001$; effect size r = 0.45; rank-biserial r ≈ 0.53).

DISCUSSION

This cross-sectional study found a significant association between increased BMI and poorer anterior knee pain-related function among physically inactive young adults. Participants with normal BMI had substantially better Kujala mean rank scores than participants with increased BMI, indicating lower symptom burden and better functional capacity. The statistically significant Mann–Whitney U result supports the hypothesis that higher BMI is associated with greater anterior knee pain-related limitation in this population; however, because the study design was cross-sectional and the analysis was unadjusted, the findings should be interpreted as an association rather than evidence of causation or an independent predictive effect.

The observed relationship is biologically plausible because excess body weight can increase mechanical loading across the knee and patellofemoral joint during routine activities such as stair climbing, squatting, sitting with flexed knees, and transitional movements. Increased loading may contribute to altered patellar tracking, higher joint stress, soft-tissue strain, and reduced tolerance to functional activity. Previous literature has also suggested that overweight and obesity may worsen pain and functional limitation through both biomechanical and inflammatory pathways, including increased joint reaction forces and adipose-related systemic inflammation (3,4). These mechanisms may be particularly relevant in physically inactive individuals, where reduced quadriceps and hip muscle conditioning can further compromise dynamic knee control.

An important strength of the present study is that all participants were classified as physically inactive using IPAQ-based MET values. This helped reduce variability related to physical activity exposure and allowed a more focused comparison between BMI groups. Despite similarly low activity levels, participants with increased BMI demonstrated worse knee-related function, suggesting that elevated BMI may contribute additional clinical burden beyond inactivity alone. This finding is consistent with previous evidence showing that young adults with patellofemoral pain and higher BMI may demonstrate poorer functional capacity and reduced lower-limb strength (7).

The findings have practical implications for screening and rehabilitation. Young adults with increased BMI who report anterior knee pain may benefit from early assessment of knee function, targeted quadriceps and hip strengthening, graded physical activity, and weight-management counseling. Rehabilitation should not focus only on pain reduction but should also address modifiable risk factors such as physical inactivity, lower-limb weakness, and excess body weight. Since anterior knee pain during young adulthood may discourage activity participation, early intervention may help prevent a cycle of pain, inactivity, weight gain, and further functional decline.

This study has several limitations. The use of purposive sampling limits generalizability beyond similar university-based populations. Physical activity was assessed through self-report, which may introduce recall or reporting bias. The diagnosis of anterior knee pain-related function was based on the Kujala

scale rather than clinical examination or imaging, so other knee pathologies could not be fully excluded. The BMI range extended beyond the overweight category; therefore, the higher BMI group should be described as an increased-BMI group unless obese participants are separately analyzed. Finally, no multivariable adjustment was performed for potential confounders such as gender, age, exact BMI value, or department, so causal or independent-effect claims should be avoided.

CONCLUSION

Physically inactive young adults with increased BMI demonstrated significantly poorer Kujala anterior knee pain-related function than those with normal BMI. These findings indicate a meaningful association between elevated BMI and greater anterior knee pain-related functional limitation in young adults. BMI screening, weight-management counseling, and structured physiotherapy interventions targeting lower-limb strength and functional movement should be considered in the prevention and management of anterior knee pain-related disability in this population.

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