JHWCR JOURNAL OF HEALTH, WELLNESS AND COMMUNITY RESEARCH 3007-0570

https://doi.org/10.61919/ry2qrk28

Original Article

Evaluation of BMI, Activity Level and Musculoskeletal Assessment Through Standardized Nordic Questionnaire in Females Performing Exercises Weight-Bearing Vs Non-Weight Bearing In Gym: A Cross-Sectional Study

Soha Asif[1], Azka Khan[1], Shahana Batool[1], Aqsa Akram[1], Sajjad Ali Sajjad[2]*

[1] Student, Department of Physical Therapy and Rehabilitation, School of Health Sciences, University of Management and Technology, Lahore, Pakistan
[2] Assistant Professor, Department of Clinical Services, School of Health Sciences, University of Management and Technology, Lahore, Pakistan

***Corresponding author: Sajjad Ali Sajjad, sajjad.ali@umt.edu.pk**

"Cite this Article" **Received**: 25 February 2026; **Accepted**: 14 June 2026; **Published**: 08 July 2026
Author Contributions: Concept: SA and AK; Design: SB and AA; Data Collection: SA, AK, SB, and AA; Supervision: SAS; Analysis: SA, AK, SB, AA, and SAS; Drafting: SA, AK, SB, and AA; Critical Review: SAS. **Ethical Approval**: University of Management and Technology, Lahore, Pakistan **Informed Consent**: Written informed consent was obtained from all participants; **Conflict of Interest**: The authors declare no conflict of interest. **Funding**: No external funding; **Data Availability**: Available from the corresponding author on reasonable request; **Acknowledgments**: . Research Supervisor: Dr. Maida Ilyas, Lecturer Head Supervisor: Dr. Danyal Ahmed, Assistant Professor, Knowledge Unit of Health Sciences, University of Management and Technology, Sialkot, Pakistan

ABSTRACT

Background: Weight-bearing and non-weight-bearing exercises differ in mechanical loading, muscular demand, and potential musculoskeletal effects. Among female gym participants, these exercise patterns may be associated with differences in body mass index, physical activity level, and musculoskeletal symptoms. Objective: To evaluate BMI, IPAQ-based physical activity level, and musculoskeletal assessment among female gym participants performing weight-bearing versus non-weight-bearing exercises. Methods: This cross-sectional observational study included 370 women aged 20–40 years who attended gyms in Lahore at least three days per week for a minimum of six months. Participants were selected through convenience sampling. BMI was calculated using weight and height, physical activity was assessed using the International Physical Activity Questionnaire, and musculoskeletal symptoms were assessed using the Nordic Musculoskeletal Questionnaire. Associations between BMI category and IPAQ-based physical activity level within exercise groups were examined using chi-square tests in SPSS version 25. Results: In the weight-bearing exercise group, Pearson chi-square testing showed a significant association between BMI category and IPAQ-based physical activity level, $\chi^2 = 39.526$, df = 26, p = 0.043. In the non-weight-bearing exercise group, no significant association was observed, $\chi^2 = 21.244$, df = 18, p = 0.267. Likelihood ratio and linear-by-linear association tests were not significant in either group. Conclusion: BMI category and physical activity level were associated among women performing weight-bearing exercise but not among those performing non-weight-bearing exercise. These findings should be interpreted as cross-sectional associations rather than causal effects. Keywords: Body Mass Index; Physical Activity; IPAQ; Nordic Musculoskeletal Questionnaire; Weight-Bearing Exercise; Non-Weight-Bearing Exercise; Female Gym Participants.

INTRODUCTION

Weight-bearing exercise exposes the musculoskeletal system to mechanical loading generated through body weight, external resistance, or ground reaction forces, whereas non-weight-bearing exercise is typically performed with reduced axial loading and lower skeletal impact. In gym-based settings, weight-bearing exercise may include resistance and strengthening activities such as leg press, deadlift, calf raises, chest press, lateral pull-downs, biceps curls, and triceps extensions, while non-weight-bearing exercise may include seated strengthening, seated cycling, swimming, and other low-impact activities. These exercise modes differ not only in biomechanical demand but also in the degree of muscular

ISSN 3007-0570 |

recruitment, joint loading, and potential osteogenic stimulus produced during regular physical activity (1).

The distinction between weight-bearing and non-weight-bearing exercise is clinically relevant for women because skeletal loading contributes to musculoskeletal adaptation across the life course. Previous evidence suggests that weight-bearing and high-impact exercise can positively influence bone health in girls and women by stimulating adaptive skeletal responses, although the magnitude of benefit depends on age, exercise intensity, frequency, duration, and baseline health status (1,2). Resistance and impact-based activities have also been reported to support musculoskeletal fitness and may contribute to better long-term physical function, whereas non-weight-bearing activities are often more strongly associated with cardiovascular conditioning, endurance, and low-impact participation for individuals who cannot tolerate higher loading (3). These differences suggest that exercise type may be associated with distinct profiles of physical activity level, body mass index, and musculoskeletal symptoms among active women.

Although several studies have examined weight-bearing exercise in relation to bone mineral density, osteogenic response, or clinical populations such as postmenopausal women, osteoporotic patients, and individuals recovering from hip fracture, fewer data are available from apparently healthy young and middle-aged women who regularly attend gyms (2–4). This gap is important because gym participants frequently perform mixed exercise routines, and the relationship between dominant exercise type, body mass index, self-reported physical activity level, and musculoskeletal symptoms may differ from findings reported in clinical or older populations. In addition, BMI alone does not capture body composition or musculoskeletal function, but it remains a practical screening indicator when interpreted alongside physical activity and symptom assessment.

The International Physical Activity Questionnaire provides a standardized method for estimating self-reported physical activity, while the Nordic Musculoskeletal Questionnaire allows systematic assessment of musculoskeletal symptoms across body regions. Using these tools together may provide a broader profile of exercise-related health status than BMI alone. For female gym participants, this combined assessment is particularly relevant because exercise type may be associated with differences in activity level, loading exposure, and regional musculoskeletal complaints. However, cross-sectional data can identify associations only and cannot establish whether one exercise type causes changes in BMI, physical activity, or musculoskeletal symptoms.

Therefore, the present cross-sectional study aimed to evaluate BMI, physical activity level, and musculoskeletal symptoms among female gym participants performing weight-bearing versus non-weight-bearing exercises in Lahore. The study specifically sought to determine whether exercise category was associated with BMI classification, IPAQ-based physical activity level, and Nordic Musculoskeletal Questionnaire findings among women without known degenerative disease or major musculoskeletal pathology.

MATERIAL AND METHODS

This cross-sectional observational study was conducted among female gym participants in Lahore, Pakistan, to evaluate body mass index, physical activity level, and musculoskeletal symptoms in women performing weight-bearing and non-weight-bearing exercises. The study design was selected because the objective was to examine associations between naturally occurring exercise categories and health-related variables at a single point in time, without assigning or modifying participants' exercise routines. The primary exposure was exercise category, classified as weight-bearing exercise or non-weight-bearing exercise according to the dominant type of gym activity reported by the participant. Weight-bearing exercise included activities involving axial loading, resistance training, or body-weight-supported strengthening against gravity or external resistance, whereas non-weight-bearing exercise included seated, supported, or low-impact activities performed with minimal body-weight loading.

The study population consisted of 370 women aged 20 to 40 years who were regularly attending gyms in Lahore. Participants were recruited through convenience sampling from gym settings and university-associated populations where eligible women were accessible. Women were included if they had been attending the gym at least three days per week for a minimum duration of six months and were able to provide the required information regarding exercise participation, height, weight, physical activity, and musculoskeletal symptoms. Women were excluded if they reported known degenerative disease, diagnosed osteoporosis, existing major musculoskeletal disorder, recent trauma, pregnancy, breastfeeding, or any medical condition that could substantially affect physical activity participation or musculoskeletal symptom reporting.

Eligible participants were approached in the selected gym and university settings, and the purpose of the study was explained before data collection. Verbal informed consent was obtained from participants after explaining the voluntary nature of participation, confidentiality of responses, and the right to decline or withdraw without penalty. Administrative permission was obtained from the relevant gym and university authorities before recruitment. Participant information was collected anonymously, and data were handled confidentially in accordance with basic ethical principles for observational human research.

Data were collected using a structured assessment format that included demographic information, exercise category, BMI calculation, physical activity assessment, and musculoskeletal symptom screening. BMI was calculated using measured or self-reported body weight in kilograms and height in meters according to the standard formula: weight in kilograms divided by height in meters squared. Physical activity level was assessed using the International Physical Activity Questionnaire, and musculoskeletal symptoms were assessed using the Nordic Musculoskeletal Questionnaire. The Nordic questionnaire was used to record self-reported symptoms across standard body regions, allowing systematic identification of musculoskeletal complaints among participants in both exercise categories.

The main study variables were exercise category, BMI, IPAQ-based physical activity level, and Nordic Musculoskeletal Questionnaire findings. Exercise category was treated as the primary exposure variable. BMI and physical activity level were treated as key health-related outcome variables, while musculoskeletal symptoms were assessed as self-reported regional complaints. For analysis, categorical variables were summarized using frequencies and percentages. Continuous variables, where available, were summarized using appropriate descriptive statistics. Associations between categorical variables were examined using the Pearson chi-square test. Likelihood ratio and linear-by-linear association tests were also reported where applicable. Statistical analysis was performed using SPSS version 25, and a p-value less than 0.05 was considered statistically significant.

To reduce selection and information bias, the same data collection approach was used for all participants, and standardized instruments were applied for physical activity and musculoskeletal symptom assessment. Eligibility criteria were defined before data collection to reduce heterogeneity related to major disease, trauma, pregnancy, or known musculoskeletal pathology. Because the study used convenience sampling and self-reported questionnaire data, the findings were interpreted as observational associations rather than causal effects. The cross-sectional design did not permit assessment of temporal change in BMI, physical activity level, or musculoskeletal symptoms over time.

RESULTS

A total of 370 female gym participants aged 20–40 years were included in the analysis. All participants met the eligibility criteria of regular gym attendance for at least three days per week for a minimum of six months. The available participant-level information from the manuscript is summarized in Table 1.

The study included 370 women who were regular gym participants. The manuscript reports the use of BMI calculation, IPAQ-based physical activity assessment, and the Nordic Musculoskeletal

Questionnaire for musculoskeletal symptom screening. However, group-wise distributions for weight-bearing and non-weight-bearing exercise categories, BMI categories, IPAQ levels, and Nordic musculoskeletal symptom regions were not provided in the available results.

Table 1. Available Participant and Study Characteristics

Characteristic	Value
Total participants analyzed	370
Sex	Female
Age range, years	20–40
Minimum gym attendance frequency	≥3 days/week
Minimum gym attendance duration	≥6 months
Study design	Cross-sectional observational
Sampling method	Convenience sampling
Study setting	Gyms and university-associated populations in Lahore
BMI assessment	Weight/height^2
Physical activity assessment	IPAQ
Musculoskeletal symptom assessment	Nordic Musculoskeletal Questionnaire
Statistical software	SPSS version 25
Statistical significance threshold	$p < 0.05$

Table 2. Association Between BMI Category and IPAQ-Based Physical Activity Level Within Exercise Groups

Exercise Group	Test	χ^2	df	p-value
Weight-bearing exercise	Pearson Chi-square	39.526	26	0.043
Weight-bearing exercise	Likelihood ratio	28.483	26	0.335
Weight-bearing exercise	Linear-by-linear association	2.419	1	0.120
Non-weight-bearing exercise	Pearson Chi-square	21.244	18	0.267
Non-weight-bearing exercise	Likelihood ratio	22.223	18	0.222
Non-weight-bearing exercise	Linear-by-linear association	0.293	1	0.588

Abbreviations: BMI, body mass index; IPAQ, International Physical Activity Questionnaire; χ^2, chi-square statistic; df, degrees of freedom.

Within the weight-bearing exercise group, the Pearson chi-square test showed an association between BMI category and IPAQ-based physical activity level, $\chi^2 = 39.526$, df = 26, $p = 0.043$. The likelihood ratio test for the same comparison was not statistically significant, $\chi^2 = 28.483$, df = 26, $p = 0.335$, and the linear-by-linear association was also not statistically significant, $\chi^2 = 2.419$, df = 1, $p = 0.120$. These findings suggest that the observed association in the weight-bearing exercise group was present on Pearson chi-square testing but was not supported by a clear ordinal trend.

Within the non-weight-bearing exercise group, the Pearson chi-square test did not show an association between BMI category and IPAQ-based physical activity level, $\chi^2 = 21.244$, df = 18, $p = 0.267$. The likelihood ratio test, $\chi^2 = 22.223$, df = 18, $p = 0.222$, and the linear-by-linear association, $\chi^2 = 0.293$, df = 1, $p = 0.588$, were also not statistically significant. These results indicate that no statistically supported association between BMI category and IPAQ-based physical activity level was observed in the non-weight-bearing exercise group based on the available analysis.

Overall, the available inferential findings show that BMI category and IPAQ-based physical activity level were associated within the weight-bearing exercise group on Pearson chi-square testing, whereas no comparable association was observed within the non-weight-bearing exercise group. Because the study was cross-sectional, these results should be interpreted as associations rather than evidence that weight-bearing exercise reduced BMI or increased physical activity level. Group-wise denominators, BMI category frequencies, IPAQ category frequencies, and Nordic Musculoskeletal Questionnaire outcomes are required for a more complete interpretation of the comparative pattern between exercise categories.

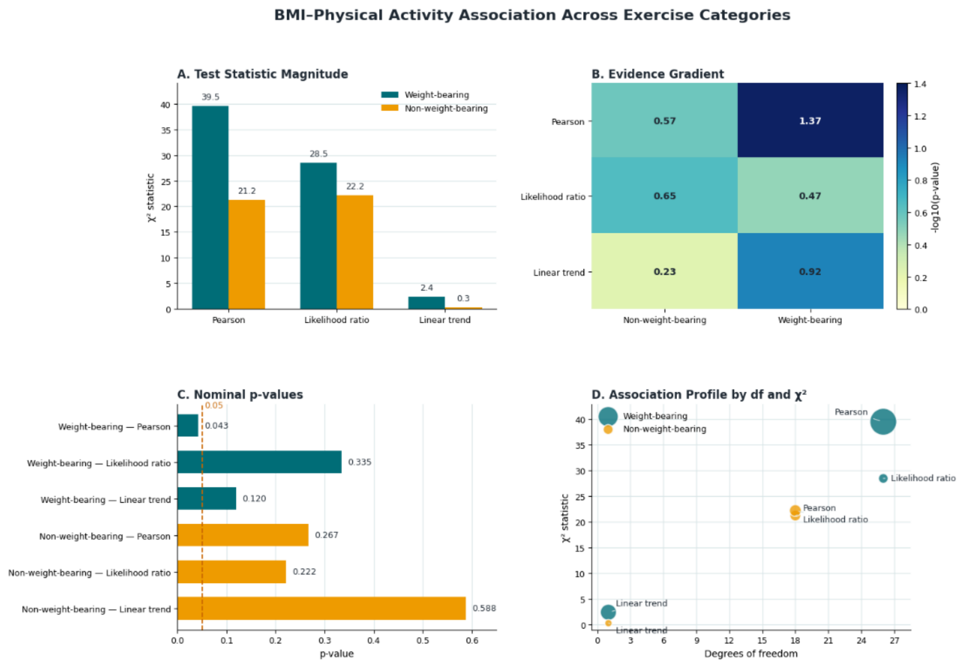

Figure 1. BMI–physical activity association profile across exercise categories.

The panelled figure summarizes the reported chi-square analyses between BMI category and IPAQ-based physical activity level within weight-bearing and non-weight-bearing exercise groups. Pearson chi-square testing showed a higher test statistic in the weight-bearing group, $\chi^2 = 39.526$, df = 26, $p = 0.043$, compared with the non-weight-bearing group, $\chi^2 = 21.244$, df = 18, $p = 0.267$. The likelihood ratio and linear-by-linear association tests were not statistically significant in either group, indicating that the observed association in the weight-bearing group was not supported by a consistent ordinal trend. These findings should be interpreted as cross-sectional associations rather than evidence of causal reduction in BMI or increase in physical activity.

DISCUSSION

The present cross-sectional study evaluated BMI, IPAQ-based physical activity level, and musculoskeletal assessment among female gym participants performing weight-bearing and non-weight-bearing exercises. The available association analysis showed that BMI category and IPAQ-based physical activity level were significantly associated within the weight-bearing exercise group on Pearson chi-square testing, whereas no statistically significant association was observed within the non-weight-bearing exercise group. This suggests that women whose dominant gym activity involved weight-bearing exercise may have a different BMI–physical activity profile compared with those performing non-weight-bearing exercise. However, because the study design was cross-sectional, this finding should be interpreted as an association only and not as evidence that weight-bearing exercise directly reduced BMI or increased physical activity.

The observed association in the weight-bearing exercise group is biologically plausible because weight-bearing and resistance-based activities generally require greater musculoskeletal loading, multi-joint muscle recruitment, and higher mechanical demand than supported or seated non-weight-bearing activities. Previous literature has shown that weight-bearing and high-impact exercise can stimulate musculoskeletal adaptation and support bone-related outcomes in girls and women, particularly when exercise intensity and loading are sufficient (1,2). Similarly, resistance and weight-bearing exercise have been reported to contribute to strength, physical fitness, and functional capacity, while non-weight-bearing activity may be more strongly directed toward cardiovascular endurance or low-impact conditioning (3). In the present study, this distinction may partly explain why BMI category and physical activity level showed an association in the weight-bearing exercise group but not in the non-weight-bearing group.

The findings should be compared cautiously with previous studies because much of the existing literature on weight-bearing exercise has focused on bone mineral density, osteoporosis, postmenopausal women, or clinical populations rather than healthy female gym participants. Studies in premenopausal and postmenopausal women have reported beneficial effects of high-impact or weight-bearing activity on bone mineral density and skeletal health markers (4–6). Other evidence indicates that exercise interventions may influence body weight, BMI, lean body mass, and visceral fat, although the magnitude and direction of effect depend on the type, duration, and intensity of exercise (10). The current study did not measure bone mineral density, body composition, lean mass, or longitudinal weight change; therefore, these mechanisms can only be discussed as possible explanations from previous literature and should not be presented as direct findings of the present analysis.

The lack of a significant association in the non-weight-bearing exercise group may indicate that low-impact or supported exercise activities produce a less distinct relationship between BMI category and self-reported physical activity level among regular gym-going women. Non-weight-bearing exercise remains clinically useful, especially for individuals requiring reduced joint loading, pain-limited exercise, or cardiovascular conditioning. Previous research has shown that non-weight-bearing exercise may be beneficial in selected musculoskeletal conditions, including chronic low back pain, and may improve participation where higher loading is not tolerated (12). However, in healthy gym participants, non-weight-bearing exercise may not provide the same loading stimulus or total-body muscular demand as weight-bearing exercise, which may partly explain the weaker association observed in this analysis.

A major strength of the study is its focus on female gym participants, a population that is commonly exposed to different exercise patterns but is less frequently studied in local observational research. The use of BMI, IPAQ, and the Nordic Musculoskeletal Questionnaire provides a practical framework for assessing body size, physical activity, and musculoskeletal symptoms together. However, the current reporting limits full interpretation because group-wise distributions for weight-bearing and non-weight-bearing exercise categories, BMI categories, IPAQ levels, and Nordic body-region symptoms were not provided. The absence of these descriptive data makes it difficult to determine which BMI categories or activity levels contributed most strongly to the observed chi-square association.

Several limitations must be considered. Convenience sampling may limit generalisability beyond the selected gyms and university-associated populations in Lahore. Self-reported physical activity and musculoskeletal symptoms may be affected by recall bias and reporting bias. BMI was used as a practical measure, but it does not distinguish fat mass from lean mass, which is especially important in gym-going populations where resistance training may increase muscle mass. The cross-sectional design prevents assessment of temporal sequence, so reverse causality is possible; women with lower BMI or higher activity levels may be more likely to perform weight-bearing exercise rather than weight-bearing exercise causing lower BMI or higher activity. Future studies should use longitudinal designs, clearly define exercise exposure by frequency, intensity, duration, and dominant exercise type, and include body composition, exercise volume, and detailed Nordic Musculoskeletal Questionnaire outcomes by body region.

Overall, the findings suggest that weight-bearing exercise is associated with a distinct BMI–physical activity relationship among female gym participants, while non-weight-bearing exercise did not show a statistically significant association in the available analysis. These results support the need for more detailed research on exercise type, physical activity patterns, BMI, and musculoskeletal symptoms in active women, particularly using stronger exposure classification and complete group-wise reporting.

CONCLUSION

In this cross-sectional study of 370 female gym participants, BMI category and IPAQ-based physical activity level showed a statistically significant association within the weight-bearing exercise group on Pearson chi-square testing, whereas no significant association was observed within the non-weight-bearing exercise group. These findings suggest that weight-bearing exercise may be linked with a more distinct BMI–physical activity profile among women who regularly attend gyms. However, the results should be interpreted cautiously because the study design does not establish causality, and the available data do not demonstrate actual reduction in BMI or increase in physical activity over time. Complete reporting of exercise-group distribution, BMI categories, IPAQ levels, and Nordic Musculoskeletal Questionnaire findings is required to strengthen interpretation. Future longitudinal studies with objective activity measurement, body-composition assessment, and detailed musculoskeletal symptom profiling are recommended.

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