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BMI as a suboptimal predictor of musculoskeletal pain among academic health professionals: A cross-sectional institutional study

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Abstract

Background: Many studies have used Body mass index (BMI) as an important risk factor for musculoskeletal pain. However, its validity remains questionable, with debate over the relative contributions of adiposity and muscle mass. This study aims to evaluate BMI a predictor of MSK pain among academic health staff.

Methods: This is a cross-sectional institutional study conducted at Al Mustaqbal University in Babylon, Iraq. 150 academic staff from the medical and health departments have been involved in the study. MSK pain was evaluated using the Arabic version of the Nordic Musculoskeletal Questionnaire. BMI was categorized according to the WHO classification. Logistic regression and Spearman correlation were used to investigate the association between BMI and MSK pain.

Results: The prevalence of 12-Month MSK pain was 80%. An inverse relationship was noticed between normal-weight participants, who reported the highest pain prevalence (84.3%) compared to overweight (89.1%) and obese (67.9%) participants ($p = 0.020$). Multivariable logistic regression showed a non-significant association between BMI and MSK pain. In comparison, clinical job role emerged as the strongest independent predictor of MSK pain (adjusted OR = 2.61, 95% CI: 1.08–6.32, $p = 0.033$). Neck pain was significantly more prevalent among normal-weight participants (64.7% vs. 21.7% among overweight participants, $p < 0.001$).

Conclusion: BMI was not a significant independent predictor of MSK pain in this study. Clinical-related academic job roles involving repetitive tasks and prolonged abnormal postures are independently related to high BMI

Keywords: Musculoskeletal disorders; Body mass index; Academic staff; Nordic Musculoskeletal Questionnaire

1. Introduction

Musculoskeletal disorders (MSDs) among the general population and working academic staff within health Technique departments have a significant impact and burden on global health. They are the leading causes of disability and sick leave in the healthcare system. (1). Those who conduct research, teach, and engage in scholarly activities face their own ergonomic challenges, unlike medical, nursing, or workcraft staff who have their own burdens. Those types of jobs, namely the clinical academic jobs, are known to involve repeated, prolonged activities of complex and fine motor tasks. (2, 3).

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MSK pain develops through different mechanisms. Adiposity-related inflammatory mediators, driven by cytokines, lead to joint degenerative changes. The other mechanism is biomechanical, leading to microtrauma from repetitive loading and abnormal posturing. (4). Body mass index is always considered a dominant metric and an important cofounder in the analysis of musculoskeletal disorders, and is always linked to these disorders (1). Evidence from general population studies demonstrated a strong association between high BMI and MSK conditions. (5, 6).

BMI carries well-documented conceptual limitations as a surrogate for adiposity: it conflates fat mass with fat-free mass, is insensitive to body fat distribution, and is subject to systematic measurement error when derived from self-report (7). These limitations might affect MSK research, where muscle hypertrophy associated with physical workloads can push workers into higher BMI categories without a corresponding increase in metabolic adiposity.

However, in the occupational context, there is a critical limitation in the evaluation of Musculoskeletal pain in these populations. Boocock et al. reported in their systematic review that an increase in spinal disorders was associated with workers' abnormal lifting maneuvers or task frequency, unrelated to body weight. (2). The job varieties and types of tasks related to jobs demonstrated a gap in evaluating BMI with MSK disorders. Many studies revealed a significant association between high BMI and MSK complaints among workers with low physical demands compared to those with high physical demands. These findings supported that a sedentary lifestyle or desk jobs might be associated with MSK disorder regardless of BMI status. (5, 8).

This study aims to evaluate the validity of BMI as a risk factor for MSK-related disorders among academic staff members. This population group is characterized by occupational heterogeneity. We hypothesize that BMI has a weak or no significant relation with MSK disorders. The secondary hypothesis is that normal-weight academic clinical staff have MSK pain prevalence comparable to obese non-clinical academic staff.

2. Methods

2.1. Study Design

This is a cross-sectional study of 150 academic staff out of 180; the response rate is 83% at Al Mustaqbal University in Babylon, Iraq. The study was conducted between July 2025 and December 2025. Ethical approval has been obtained from Al Mustaqbal University Ethical Approval Committee, reference number Reh 2-2025. Written informed consent has been obtained from each participant after a full explanation of the study's purpose.

The study included the full-time academic staff from all ranks (Assistant lecturers to Professors) in all Medical and health techniques departments (Anesthesia, radiology, laboratory medicine, and optics).

The data have been collected using the standardized Arabic version of the Nordic Musculoskeletal Questionnaire. (9) This Arabic version was developed from the original version by Kuorinka et al. in 1987 (10). The Data has been collected personally, face-to-face, to ensure accuracy. Height was measured using a Tape measure scale in (cm), and weight was measured using an electronic weighing scale in (kg). Participants were categorized according to World Health Organization criteria: normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), and obese (≥30.0 kg/m^2). Underweight participants (<18.5 kg/m^2) were excluded from analysis due to small numbers. Demographic characteristics, such as age, gender, Working hours, and associated chronic disease, have been collected. The Primary outcome was the reported prevalence of pain or dysfunction at the same time and over the last 12 months in any part of the anatomical regions of the MSK, including Neck, Upper limbs, Back, and Lower limbs. The questionnaire also included secondary outcomes related to pain (Functional limitation, interference with daily activities, and Absenteeism). To clarify occupational exposure, Job type was also classified into staff with a clinical role (Patient care) who spend more than 50% of their working hours in clinical roles, and non-clinical roles who deal with teaching and research (without patient contact) who spend more than 50% of their working hours in non-clinical roles.

To investigate the secondary hypothesis, chi-square was used to compare MSK prevalence between clinical staff (normal or low BMI) and non-clinical staff (high BMI). Moreover, BMI and MSK pain relationship with job type was investigated in the multivariable logistic regression

2.2. Statistical Analysis

Data analysis performed using SPSS version 24.0. Descriptive statistics are expressed by means ± standard deviations (SD) for continuous variables and frequencies (percentages) for categorical variables. The chi-square test has been used to compare pain across BMI categories and other categorical covariates. One-way ANOVA has been used to compare means. Independent t-tests were used to compare continuous covariates (age, working hours) between those with and without MSK pain. Spearman's rank correlation coefficient assessed the relationship between BMI (continuous) and the number of painful sites. Unadjusted odds ratios with 95% confidence intervals have been estimated for each MSK outcome using binary logistic regression with normal BMI as the reference category. A multivariable logistic regression has been used to evaluate the primary outcome for any 12 Month MSK pain. Age, gender, BMI category, job type, mean daily working hours, and chronic disease status as covariates. A Bonferroni-corrected significance threshold of α = 0.0083 (0.05/6) was applied to limit the type I error rate attributable to multiple comparisons. A two-sided p-value < 0.05 was considered statistically significant for all analyses. Sample size estimation was performed using G*Power prior to data collection to assess the odds ratio greater than 2 for the primary predictor in a logistic regression analysis with seven covariates (α = 0.05, power = 0.80). The final result demonstrates that at least 138 participants were required.

3. Results

3.1. Sample Characteristics

A total of 150 academic staff members have been involved in this study, with a mean age of 43.5 years (range 25-75 years). Males represented 66.7% (n=100) of the participants. The average daily working hours were 5.5 hr/day. About 40.7% (n=61) of the academic staff reported chronic diseases. Moreover, Clinical role-related work represent 70% (n=105) of the sample. The mean BMI of the participants was 28.1 kg/m2. The BMI has been categorized according to the WHO classification into underweight, Normal, overweight, and Obese. The prevalence of BMI has been reported in Table 1. There was no underweight among participants.

Table 1 Demographic and Occupational Characteristics of Study Participants (N = 150)

Characteristic Demographics	**Value**
Age (years), mean ± SD	43.5 ± 14.7
Age (years), median (IQR)	38 (32–55)
Male sex, n (%)	100 (66.7)
Female sex, n (%)	50 (33.3)
Clinical job role, n (%)	105 (70.0)
Non-clinical job role, n (%)	45 (30.0)
Years in current post, mean ± SD	9.0 ± 9.9
Daily working hours, mean ± SD	5.5 ± 0.7
Chronic disease present, n (%)	61 (40.7)
BMI (kg/m^2), mean ± SD	28.1 ± 4.9
Normal weight (18.5–24.9 kg/m^2), n (%)	51 (34.0)
Overweight (25.0–29.9 kg/m^2), n (%)	46 (30.7)
Obese (≥ 30.0 kg/m^2), n (%)	53 (35.3)

3.2. Prevalence of Musculoskeletal Pain

About 120 faculty members (80%) reported pain in at least one part of their body during the last 12 months, indicating a remarkably high prevalence. More than 50% reported pain in more than one region, whereas about 29% reported pain only in a single region. The most common reported region was lower back pain (46%), followed by neck pain (44.7%), ankles and feet (29%), and then Knees (28.7%). About (54%) of the academic staff reported that their pain has interfered with their daily activities. Moreover, (18.7%) reported that they have taken sick leave because of their MSK pain. Table 2 shows the distribution of pain by anatomical regions.

Table 2 Twelve-Month Prevalence of Musculoskeletal Pain by Anatomical Region (N = 150)

Anatomical Region	Participants Affected, n (%)	Rank
Lower back	69 (46.0)	1
Neck	67 (44.7)	2
Ankles and feet	44 (29.3)	3
Knees	43 (28.7)	4
Shoulders	36 (24.0)	5
Wrists and hands	32 (21.3)	6
Upper back	28 (18.7)	7
Hips and thighs	22 (14.7)	8
Elbows	21 (14.0)	9
Any region (overall)	120 (80.0)	—

3.2.1. The Association Between Body Mass Index and Musculoskeletal Pain

Against expectations, results showed an inverse association between BMI and MSK pain. The normal BMI group demonstrated the highest prevalence of MSK pain compared to participants with high BMI (χ^2 = 7.820, p = 0.020). About 84% of normal BMI participants reported any MSK pain compared to 89% of overweight and about 67.9% of obese participants. Moreover, normal-weight individuals reported pain in more than one region compared to overweight and obese individuals. However, there was no statistically significant difference (p=0.081).

BMI showed a statistically significant but weak negative association with the number of body regions affected (Spearman's ρ = -0.181, p = 0.027). The intensity of pain has a similar pattern in which functional limitation has been reported in 66.7% of normal weight participants compared to 52.2% of overweight participants and 43.4% obese participants, p=0.056. In addition, 29.4% of normal-weight individuals reported sick leave, compared with 13% and 13.2% of overweight and obese individuals, respectively (p = 0.053). However, these differences did not reach statistical significance. Table 3 demonstrates the relationship between MSK pain and BMI categories.

Table 3 MSK Pain Outcomes Stratified by BMI Category

Outcome	Normal Weight (n = 51)	Overweight (n = 46)	Obese (n = 53)	p-value
Any MSK pain, n (%)	43 (84.3)	41 (89.1)	36 (67.9)	0.020
Mean affected sites ± SD	2.82 ± 2.58	1.96 ± 1.74	1.96 ± 2.25	0.081
Functional limitation, n (%)	34 (66.7)	24 (52.2)	23 (43.4)	0.056
Absenteeism, n (%)	15 (29.4)	6 (13.0)	7 (13.2)	0.053

3.2.2. Logistic regression analysis

Normal BMI has been used as a reference; unadjusted odds ratios were calculated for MSK pain outcomes Table 4. Obese individuals had 61% lower odds of reporting any MSK pain compared to normal-weight individuals (OR = 0.39, 95% CI: 0.15–1.02), although the confidence interval marginally included the null value. For functional limitation, the protective effect was statistically significant (OR = 0.38, 95% CI: 0.17–0.85), which indicates that obese individuals had 62% lower odds of functional impairment. Overweight participants also demonstrated protective trends, though these did not reach statistical significance.

In the multivariable model (Table 5), after simultaneous adjustment for age, sex, job type, working hours, and chronic disease, the association between obesity and lower pain odds was attenuated and no longer achieved statistical significance (adjusted OR = 0.51, 95% CI: 0.18–1.43, p = 0.197). Addressing the secondary hypothesis, the normal BMI participants with a clinical role job reported a higher prevalence of pain compared to high BMI participants who have a non-clinical role. Clinical job role remained the strongest independent predictor of any MSK pain in the adjusted model (adjusted OR = 2.61, 95% CI: 1.08–6.32, p = 0.033). The Hosmer-Lemeshow test indicated adequate model fit (χ^2 = 6.42, df = 8, p = 0.600). The events per variable are 4.3, which is below the recommended threshold.

Table 4 Unadjusted Odds Ratios for MSK Pain Outcomes by BMI Category (Reference: Normal Weight)

Outcome	BMI Category	OR	95% CI	p-value
Any MSK pain	Normal	1.00 (Ref)	—	—
	Overweight	1.53	0.46–5.05	0.483
	Obese	0.39	0.15–1.02	0.055
Functional limitation	Normal	1.00 (Ref)	—	—
	Overweight	0.55	0.24–1.24	0.150
	Obese	0.38	0.17–0.85	0.018
Absenteeism	Normal	1.00 (Ref)	—	—
	Overweight	0.36	0.13–1.03	0.058
	Obese	0.37	0.13–0.99	0.048

Table 5 Multivariable Logistic Regression: Predictors of Any 12-Month MSK Pain (N = 150)

Variable	Adjusted OR	95% CI	p-value
BMI: Overweight (ref: normal)	1.38	0.38–5.02	0.622
BMI: Obese (ref: normal)	0.51	0.18–1.43	0.197
Clinical job role (ref: non-clinical)	2.61	1.08–6.32	0.033
Age (per year)	1.01	0.98–1.05	0.422
Male sex (ref: female)	0.89	0.38–2.10	0.795
Chronic disease (ref: none)	1.44	0.62–3.32	0.397
Daily working hours	1.22	0.61–2.43	0.574

3.2.3. Regional Pain Analysis

Table 6 Regional MSK Pain Prevalence by BMI Category with Bonferroni Correction (α = 0.0083)

Region	Normal n (%)	Overweight n (%)	Obese n (%)	p-value
Neck	33 (64.7)	10 (21.7)	24 (45.3)	< 0.001
Ankles/feet	22 (43.1)	11 (23.9)	11 (20.8)	0.027
Lower back	24 (47.1)	22 (47.8)	23 (43.4)	0.876
Knees	15 (29.4)	14 (30.4)	14 (26.4)	0.878
Shoulders	13 (25.5)	12 (26.1)	11 (20.8)	0.763
Wrists/hands	11 (21.6)	10 (21.7)	11 (20.8)	0.994

64% of the Normal weight participants reported Neck pain compared to 21.7% of the overweight and 45.3% of the obese participants (χ^2 = 18.078, p < 0.001). There was also a significant inverse relationship between BMI and Ankle/Foot pain, with the prevalence of Ankle/Foot pain being 43.1% among normal-weight participants, 23.9% among overweight participants, and 20.8% among obese participants (χ^2 = 7.222, p = 0.027). However, other anatomical regions, such as the lower back, are also affected. Knees, shoulders, and upper back pain in relation to BMI were not significant. A Bonferroni correction significance of α = 0.0083 (0.05/6 anatomical regions) was applied to all MSK pain regions to evaluate type I error. A threshold level of $\alpha = 0.0167$ (0.05/3 outcomes) was used. If the p-value exceeded these threshold values, the results were interpreted as non-significant

3.2.4. Effect of Job Type and Other Covariates

There was a significant relationship between job type and BMI-related MSK pain. 84.8% of clinical-related jobs showed higher prevalence than non-clinical-related jobs, 68.8% ($\chi^2 = 4.018$, $p = 0.045$). Other cofounders, such as age, gender, working hours, and presence of chronic diseases, showed no significant relation with BMI and any region of MSK pain.

4. Discussion

The fundamental limitations of BMI can explain the inverse BMI-pain relationship observed in this study, given that BMI is a measure of adiposity and that biomechanical exposures dominate metabolic contributions to MSK risk in an occupational setting.

In 2008, Burkhauser et al. revealed that BMI is flawed because it does not differentiate between fat and fat-free mass, such as muscle, which subsequently leads to Obesity misclassification. (7)

BMI measures systemic adiposity, while it ignores the biomechanical stress due to the abnormal load of tissue on certain parts of the MSK in posture (7). For example, academic staff with medical-related jobs often exhibit abnormal postures during repetitive activities and tasks, such as laboratory or radiological technicians. These abnormal postures lead to loading patterns on certain body parts that cannot be captured by measuring BMI. This explanation is also supported by Viester et al. (2013), who found a loss of BMI utility associated with work-related loads. (5). This may explain why the normal BMI clinic staff have a higher prevalence of MSK pain compared to obese non-clinical staff.

This study is contrary to many studies reporting a relationship between high BMI and MSK pain. (5, 11).The participants in those studies from the general population have low physical demands. Additionally, self-reported BMI is susceptible to bias.

An analytical cross-sectional study conducted by Mortada et al. (2026) to investigate the prevalence of MSK pain among academic staff members in Saudi Arabia and its relation with BMI. The study reported no significant relation between BMI and MSK pain after adjusting for ergonomic and psychosocial factors. On the other hand, the study revealed that MSK pain might be associated with prolonged sitting, poor posture, and job stress. (12, 13). Another study by Fikre et al. (2024) among Laboratory workers in Ethiopia demonstrated that MSK pain was associated with other predictors, stronger than BMI, such as sitting time of more than 4 hours daily. (14). The finding of MSK pain across many different groups, such as labs, university staff, teaching and hotel workers, all of whom have variable physical demands, suggested that BMI is not a useful tool for assessing MSK pain as a predictor. The link between BMI and MSK pain in physically demanding jobs is considered a weak predictor. (4). Gandolfi et al. (2021) conducted a cross-sectional study of 284 Dental profession participant, the study demonstrated no association between body weight and MSK pain (15)

Normal BMI clinical academic staff reported more pain than obese non-clinical academic staff in this study. These findings demonstrated that the physical stress of the job has the greatest impact on MSK, compared to BMI. This finding is against the traditional belief that states the negative effect of BMI on MSK pain. (16). These findings also have broader implications. Earlier research showed that the relationship between body composition and work outcomes is far more complex than BMI alone can capture (7).

Our results build on this by showing that effective injury prevention in the workplace requires more precise measurements—ones that can separate body fat from muscle mass, while also accounting for the specific physical demands of each job role (7).However, most studies confirmed the need for different ergonomic and physical measurements to overcome most of the MSK pain -related jobs (17-19)

4.1. Limitations

This study has several limitations. Firstly, it is a cross-sectional study, which precludes causal interference; it cannot determine the relationship between BMI and pain. Secondly, it is a single-institute sample, and multicentre studies would enhance generalizability. Thirdly, the nature of physical activity, along with workplace assessment, was not collected. A longitudinal design study is recommended to confirm these findings.

5. Conclusion

In this study, BMI was not a significant predictor of 12 Month MSK pain in association with Gender, age, working hours, and chronic disease. This inverse BMI relation was attenuated in the multivariable analysis. Abnormal posture and prolonged, repetitive tasks may contribute to musculoskeletal pain.

Compliance with ethical standard

Disclosure of conflict of interest

No Conflict of interest to be disclosed.

Statement of informed consent

Informed consent from all participants was obtained.

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