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Relationship between Body Mass Index and Musculoskeletal Disorders among Women Cultivators

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Abstract

Musculoskeletal disorders (MSDs) represent as a major public health problem among working individuals. Overweight/obesity is an important independent risk factor for MSDs. Therefore, a cross-sectional study was undertaken to investigate the relationship between body mass index (BMI) and MSDs among the women cultivators. Anthropometric measures were taken in 407 participants using standard protocols and BMI was calculated. MSD was assessed with the modified Nordic Questionnaire technique. The relationship between BMI and MSDs was analyzed with logistic regression. It was seen that 33.66 per cent of the participants were underweight while 11.3 per cent of them were overweight/obese. The overweight/obese participants had significantly higher prevalence of MSDs in neck, shoulder, back and hip regions compared with their normal BMI counterparts. The underweight group had also a significant higher prevalence of MSDs in neck region than the normal weight group. Both overweight/obese and underweight participants were more likely to have MSDs as compared to their normal-weight counterparts. The present study highlights the facts that the prevalence of MSDs was high in both underweight and overweight/obese groups as compared to the normal weight women. This indicated that an U-shaped association exists between BMI and MSDs. Furthermore, the association was found to be stronger for overweight/obese individuals as compared to those underweight.

***Key words**: Body Mass Index, Cultivator, Musculoskeletal disorders, Overweight, Underweight.*

Musculoskeletal disorders (MSDs) are defined as a group of injuries that affect the musculoskeletal system including nerves, tendon sheaths and related to bones, muscles and supporting structures such as inter-vertebral discs[1]. MSDs develop gradually over a period of week, months or even years due to repeated exertions and movements of the body. Work-related MSDs belong to a collection of health problems that are more prevalent among the working class than the general population[2]. Work-related MSDs constitute an important occupational health problem for both developed and developing countries, with rising costs of wage compensation and medical expenses, reduced productivity and lower quality of life[3,4]. Christensen et al.[5] stated that MSDs related to work are a major cause of disability amongst the working individuals.

The origin of MSDs is complex and multi-factorial. Many factors such as heavy lifting[6], high job demands[7,8], awkward postures[9,10], prolonged work activity[11] etc. have already been identified that cause of work related MSDs. Ergonomic workstation helps in the reduction of work related MSDs and stress as well as throws an opportunity to have a better work performance for better and faster production. However, another factor is the body mass index (BMI), which influences the MSDs even in a developed ergonomic set-up. Overweight and obesity are one of the world's most challenging public health problems[12]. Overweight and obesity are well

documented to be associated with major chronic illnesses, including diabetes, hypertension, heart diseases, arthritis, cancer, and all cause mortality[5,13-15]. Overweight/obesity has also been shown to increase the risk for musculoskeletal pain[16-18]. Obesity is associated with negative consequences amongst working populations including more frequent absenteeism, workplace injury and higher health care costs[13].

It is generally believed that there is a relation between obesity and musculoskeletal disorders. However, scientific evidence of this relation remains unclear. The Centre for Disease Control (CDC) reported that in the United States, more than 31 per cent of obese adults consulted a doctor for the diagnosis of arthritis as compared to only 16 per cent of non-obese people[19]. Han et al.[20] reported that a high waist : hip ratio was significantly associated with lower back pain. Several researchers showed that high BMI is an independent risk factor for the development of MSDs[5,21,22]. The nature and extent of the impact of obesity on the musculoskeletal system is not well appreciated. The chronic pain and disability associated with musculoskeletal conditions not only significantly affect an individual's quality of life but often result in the early uptake of a sedentary lifestyle associated with various serious co-morbidities. Therefore, a cross-sectional study was undertaken to investigate the association between BMI and MSDs at different body regions among the female cultivators.

Methodology

Study Design: This cross-sectional descriptive study was conducted among 663 women participants engaged in different works of rice and potato cultivation. The respondents were selected from different villages of various districts of West Bengal state, India. The eligibility criteria of the respondents for inclusion in the study were: aged 18 - 50 years, apparently healthy individuals, not suffering from any acute illness and who were self-satisfied with their normal day-to-day work schedule at the time of measurements. Individuals with background of heart disease, chronic hypertension, diabetes mellitus, respiratory diseases or accident affecting musculoskeletal system were excluded from the study. Pregnant and lactating women were also excluded from the study. During the field visits, the protocol of the study was explained verbally in local language (Bengali). Written and signed consent was obtained from the women participants. Ethical approval and prior permission was obtained from the Institutional Ethics Committee before commencement of the study and the study was performed in accordance with the ethical standards of the committee and with the Helsinki Declaration. During the field visits, a survey was conducted to gather information on experience of the work on the basis of a questionnaire.

Anthropometry Measures: Anthropometric measurements and skin fold thickness of the study participants were taken following the standard technique and appropriate landmarks. The equipment consisted of an anthropometer (Hindustan Minerals), skin fold caliper (Holtain) and portable weighing machine (Libra). From the measures of height and weight of the participants, BMI was computed and from the skin fold data, total body fat and lean body weight were determined by calculating body density[23] and percentage of body fat[24].

$$\text{BMI} = \text{Weight (kg)} / \text{Height}^2 \text{ (meter)}$$

Body density (gm/cc) = 1.0994921 – 0.0009929 (Sum of triceps, suprailiac and thigh skin folds) + 0.0000023 (sum of the same three skin folds)^2 – 0.0001392 (Age in years).

$$\text{Fat percentage (fat \%)} = \{(4.95 \div \text{Body density}) - 4.5\} \times 100$$

$$\text{Total weight of fat (TWF)} = (\text{Weight in kg} \times \text{fat percentage}) \div 100$$

$$\text{Lean body weight (LBM)} = \text{Total weight (kg)} - \text{Total weight of fat (kg)}.$$

Musculoskeletal Disorder: MSD of the participants was evaluated by the modified Nordic questionnaire technique[25]. The questionnaire emphasized their individual details, type of work and the occurrence or frequency of pain felt in different parts of their bodies.

Statistical Analysis: Descriptive characteristics of the participants were presented as means ± standard deviation and percentages. χ^2 test was performed to compare the groups for categorical variables. The association of BMI with MSDs was analyzed with logistic regression after adjusting age, work experience and work categories; and expressed by the Odd Ratio (OR) and its 95 per cent confidence interval (CI). In the categorical analyses involving BMI, the interval 18.5-24.9 kg/m^2 was considered as the reference group. The data were analyzed for statistical significance by using the statistical package of social science (SPSS 20.0) software. A *p* value below 0.05 was denoted as significant.

Findings

The physical characteristics and experience of the work of the participants has been shown in Table 1. Before the follow-up, complete information on the experience of work was noted on the basis of a questionnaire. Results show that about 36.13 per cent of the workers had a work experience of ≤5 years, 46.45 per cent had a work experience of 6 - 15 years and 17.42 per cent had a work experience of at least 16 years.

Table 1
The Physical Characteristics and Work Experience of Women Cultivators

Parameters	Mean ± SD	Range
Age (years)	38.33 ±13.09	18-50
Height (cm)	151.25 ±6.43	133.8-164.5
Weight (Kg)	44.17 ±10.01	29.5-76.0
BMI (Kg/m^2)	19.23 ±3.7	13.70-33.15
Thigh skin fold (mm)	17.118.96±	5.4-37.4
Triceps skin fold (mm)	14.618.91±	3.6-35.2
Supra-iliac skin fold (mm)	14.238.73±	3.2-34.8
Body density (gm/cc.)	1.05±0.02	1.01-1.08
Body fat percentage (BF %)	19.388.67±	8.13-38.74
Total body fat (Kg)	9.25±٦,٢٤	2.41-28.46
Lean body mass (kg)	34.914.82±	24.59-55.57
Experience (Years)	13.83±10.43	1-35

Nutritional status of the participants was assessed from their BMI value. Based on the BMI cut-off value[26], the participants were subdivided into three nutritional categories viz., underweight, normal and overweight/obese. It was found that 33.66 per cent of the respondents were underweight. About 55 per cent of them were normal while 11.3 per cent of them were overweight/obese.

The prevalence of MSDs among the women across different BMI categories was studied and it was found that the prevalence of MSDs in different body segments was low in the normal group as compared to the underweight and overweight/obese groups (Table 2). As depicted in Table 2, the overweight/obese participants had a significantly higher prevalence of MSD at neck ($p<0.01$), shoulder ($p<0.05$), upper back ($p<0.05$), lower back ($p<0.05$) and hip ($p<0.05$) regions compared with their normal BMI counterparts. Underweight group also had a significant higher prevalence of MSD at neck ($p<0.05$) than the normal weight group.

Table 2
Prevalence of Musculoskeletal Disorders across BMI Categories

Body Segment	Underweight (BMI<18.5 kg/m^2)	Normal (BMI 18.5 – 24.99 kg/m^2)	Overweight/Obese (BMI ≥25 kg/m^2)
Neck	79 (57.66%)*	104 (46.43%)	31 (67.39%)**
Shoulder	104 (75.91%)*	147 (65.63%)	37 (80.43%)*
Elbow	94 (68.61%)	132 (58.93%)	29 (63.04%)
Wrist	91 (66.42%)	141 (62.95%)	35 (76.09%)
Upper Back	88 (64.23%)	136 (60.71%)	35 (76.09%)*
Lower Back	126 (91.97%)	197 (87.95%)	45 (97.83%)*
Hip	91 (66.42%)	135 (60.27%)	35 (76.09%)*
Knee	69 (50.36%)	91 (40.63%)	24 (52.17%)
Feet	50 (36.5%)	86 (38.39%)	19 (41.3%)

*Normal *p<0.05; **p<0.01*

The impact of BMI on the prevalence of MSDs is presented in Table 3. Logistic regression analysis showed that both overweight/obese and underweight participants were more likely to have MSDs as compared to their normal-weight counterparts. The Odd Ratio of neck discomfort of overweight/obese and underweight groups were 2.38 (95% CI: 1.22-4.66; p<0.01) and 1.57 (95% CI: 1.02-2.41; p<0.05) compared to the normal weight (OR = 1.00). The Odd Ratio of shoulder, upper back, lower back and hip discomforts of overweight/obese group were 2.15 (95% CI: 0.99-4.69), 2.06 (95% CI: 0.99-4.27), 6.17 (95% CI: 0.82-46.59) and 2.09 (95% CI: 1.01-4.35) as compared to the normal-weight (OR = 1.00). The smallest association between BMI and Musculoskeletal Disorders was found in the respondents of the underweight category while it was found to be the highest in the respondents of overweight/obese category. For both overweight/obese and underweight groups, multinomial logistic regression analysis demonstrated that even after controlling the effect of age, work experience and occupation; BMI had a significant impact on MSDs.

Table 3
Cross-sectional Associations between BMI and Musculoskeletal Disorders

Body Segment	Underweight (BMI: <18.5 kg/m^2)		Overweight/Obese (BMI: ≥25 kg/m^2)	
	Unadjusted	Adjusted#	Unadjusted	Adjusted#
Neck	1.57 (1.02-2.41)*	1.58 (0.98-2.55)	2.38 (1.22-4.66)**	2.03 (0.99-4.19)
Shoulder	1.65 (1.02-2.66)*	1.85 (1.08-3.16)*	2.15 (0.99-4.69)	2.4 (1.05-5.49)*
Elbow	1.52 (0.97-2.38)	1.52 (0.92-2.51)	1.19 (0.62-2.29)	1.17 (0.57-2.38)
Wrist	1.16 (0.74-1.82)	1.17 (0.71-1.94)	1.87 (0.9-3.88)	1.63 (0.74-3.6)
Upper Back	1.16 (0.75-1.8)	1.04 (0.64-1.7)	2.06 (0.99-4.27)	2.16 (0.99-4.66)*
Lower Back	1.57 (0.75-3.28)	1.36 (0.61-3.04)	6.17 (0.82-46.59)	6.29 (0.8-49.4)
Hip	1.3 (0.84-2.03)	1.41 (0.85-2.36)	2.09 (1.01-4.35)	1.83 (0.82-4.1)
Knee	1.48 (0.97-2.27)	1.76 (1.07-2.91)*	1.59 (0.84-3.01)	1.61 (0.78-3.31)
Feet	0.92 (0.59-1.43)	0.76 (0.45-1.28)	1.13 (0.59-2.15)	1.01 (0.48-2.1)

**p<0.05; **p<0.01*
Data are presented as Odd Ratio (95% confidence interval), with normal weight as reference category
after adjusting age, work experience, occupation

Discussions

Obesity has become a major health problem due to its increasing prevalence, and associated morbidity and mortality[27]. The global burden of obesity is rising at an alarming rate. The World Health Organization estimates that more than one billion people are overweight and of these, 300 million are obese[28]. Overweight or obesity has a strong relationship with diabetes and cardio-vascular diseases like hypertension, coronary heart disease, etc.[15,29,30] Despite the associations between obesity and heart disease, diabetes and other chronic diseases; elevated BMI is considered a risk factor for MSDs [31,32]. Overweight or obesity has been implicated in the development or progression of a wide variety of MSDs. According to Wright et al.[31], and Stone and Broderick[32], overweight/obese individuals were more likely to suffer from chronic widespread pain. The nature and extent of the impact of obesity on the musculoskeletal disorders is not well for the individuals. However, there are no widely reference levels in the region's diverse national groups in relation to adiposity that predict co-morbidities such as MSDs. This lack of useful epidemiological data is the reason why the researchers attempted to investigate the association between BMI and MSDs amongst the female cultivators.

The present study highlights the facts that the prevalence of MSDs was high in both underweight and overweight/obese groups as compared to normal-weight women. This indicated the U-shaped relation between BMI and MSDs. Several studies observed a positive association between BMI and increased risk of MSDs[16,17]. Bihari et al.[18] stated that the risk of MSDs amongst the overweight/obese individuals was 1.7 times higher than the non-overweight participants. Fransen et al.[33] reported that obesity was a significant, independent determinant of lower back pain. Excessive body weight has also been found to increase the risk for musculoskeletal pain[16,34]. While the results of the current research demonstrate a link between BMI and MSDs amongst the study participants, indicating both underweight and overweight/obese as a potential causes of MSDs; however, the cross-sectional design has limitations to rule out alternative explanations. One such explanation may be that obesity may increase the risk of lower back pain, for example, because of lumbar disc disorders through mechanical load[35,36]. Increased mechanical load across the joints are likely to play a larger role in the relationship between a high BMI and weight-bearing joints. For carpal tunnel syndrome (CTS), an increase in upper extremity musculoskeletal symptoms associated with obesity has been attributed to increased adipose tissue in the carpal tunnel, causing median nerve compression[37,38]. Adams and Roughley[39] stated in their study that mechanical load is the principal factor for initiating the degenerative process in the lumbar spine. In addition to mechanical load, obesity may cause lower back pain through low-grade systemic inflammation[35,36]. Rosen and Spiegelman[40] and Shiri et al.[41] reported that adipose tissue produces adipokines as well as pro- and anti-inflammatory cytokines (e.g. tumor necrosis factor-a, interleukin-6) that increase the release of C-reactive protein. C-reactive protein is a nonspecific marker of inflammatory effects of adipose tissue. Shiri et al.[41] reported that women with a normal waist circumference and high C-reactive protein level tended to more often report continuous lower back pain than those with low C-reactive protein levels. Leptin, an adipokine produced by adipose tissue, stimulates the synthesis of pro-inflammatory cytokines and nitric oxide; that is, it is directly linked to pain modulation. Kutlu et al.[42] implies that leptin may increase pain sensitivity.

It is also interesting to note that the underweight women had a significant association between BMI and MSDs. There was ample evidence showing a strong association between overweight/obesity and MSDs[16-18]; however, the present study showed that low BMI or underweight is an independent risk factor for the development of MSDs. Attar[43] also noted in his/her study

that the risk of MSDs among underweight individuals was 2.66 times higher than the normal weight participants. It is may be due to being underweight is related to decreased muscular strength, weakness and lowered physical activity[44,45].

In the present study, BMI was found to be associated with musculoskeletal symptoms. This study showed that the prevalence of MSDs was high in both underweight and overweight/obese groups. Furthermore, the association was stronger for overweight/obese individuals as compared to the underweight women. A decrease in adiposity is one of the most effective preventive measures for MSDs in the worker population. Therefore, attention should be paid on how to decrease the levels of fatness in this population before MSDs becomes another burden. This study presents an insight to the health professionals about the relationship between BMI and MSDs, to formulate well designed training and awareness programmes to avoid adiposity.

Limitations

The current study has certain limitations. In the present study, the association BMI with MSDs was controlled for several potential confounding factors, however some potential confounders such as environmental stress, psychological stress for instance stress, anxiety or depression disorders etc. were not studied, and consequently could not be controlled for. There are limitations associated with using cross sectional data, as in every cross sectional study, conclusion related to cause and effect cannot be drawn. A longitudinal dataset would be better suited to examine the relationship between BMI and MSDs. The relatively small number of participants which may have provided inadequate statistical power to detect some meaningful differences as statistically significant, along with mentioning potential inadequate control of confounding. However, as far as we are aware, this is the only provincial study to define the relationship between BMI and MSDs among the women cultivators. This study was conducted on women only. Additional study is needed on men participants.

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स्वास्थ्य एवं जनसंख्या:
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कृषक महिलाओं में शारीरिक द्रव्यमानक सूचकांक एवं पेशीयकंकालीय विकारों के मध्य संबंध

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सारांश

कामकाजी लोगों में पेशीयकंकालीय विकार (एमएसडी) प्रमुख स्वास्थ्य समस्या के रूप में पाया गया हैं। अत्यधिक शारीरिक वजन/स्थूलता पेशीयकंकालीय विकारों के लिए एक महत्वपूर्ण स्वतंत्र जोखिम घटक है। अतः कृशक महिलाओं में शारीरिक द्रव्यमानक सूचकांक एवं पेशीयकंकालीय विकारों के मध्य संबंध का पता लगाने के लिए एक क्रॉस–अनुभागीय अध्ययन संचालित किया गया। मानक प्रोटोकॉल का उपयोग करने वाले 407 प्रतिभागियों में एंथ्रोपोमेट्रिक उपाय किए गए और बीएमआई की गणना की गई। पेशीयकंकालीय विकार का मूल्यांकन संशोधित नॉर्डिक प्रश्नावली तकनीक से किया गया था। बीएमआई और एमएसडी के बीच संबंध का विश्लेशण लॉजिस्टिक प्रतिगमन प्रणाली से किया गया था। यह देखा गया कि 33.66 प्रतिशत प्रतिभागी कम वजन के थे, जबकि 11.3 प्रतिशत शारीरिक वजन/स्थूलता से ग्रस्त थे। शारीरिक वजन/स्थूलता से ग्रस्त प्रतिभागियों में उनके सामान्य बीएमआई समकक्षों की तुलना में गर्दन, कंधे, पीठ और कूल्हे के क्षेत्रों में एमएसडी की मात्रा आधिक थी। सामान्य वजन वर्ग की तुलना में कम वजन वाले समूह में गर्दन के क्षेत्र में एमएसडी की मात्रा आधिक थी। अधिक वजन/स्थूल और कम वजन वाले प्रतिभागियों में उनके सामान्य वजन वाले समकक्ष व्यक्तियों की तुलना में एमएसडी होने की अधिक संभावना थी। वर्तमान अध्ययन में इस पर प्रकाश डाला गया है कि सामान्य वजन वाली महिलाओं की तुलना में एमएसडी की व्यापकता कम वजन और अधिक वजन/स्थूलता से ग्रस्त लोगों में अधिक थी। यह इंगित करता है कि बीएमआई और एमएसडी के बीच एक यू–आकार का सह–संबंध विद्यमान है। इसके अतिरिक्त, कम वजन वाले लोगों की तुलना में अधिक वजन वाले/स्थूल व्यक्तियों में यह संबंध दृढ़ पाया गया।

मुख्य शब्दः शारीरिक द्रव्यमानक सूचकांक, कृषक, पेशीयकंकालीय विकार, अत्यधिक शारीरिक वजन, कम वजन