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WORK-RELATED MUSCULOSKELETAL SYMPTOMS AND THEIR ASSOCIATION WITH NUTRIENT INTAKE AND NATURE OF WORK AMONG FOOTWEAR INDUSTRY WORKERS

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Abstract:

Background: Work-related musculoskeletal disorders (MSDs) are a common occupational health problem among industrial workers, particularly in jobs involving repetitive movements and prolonged postures. Nutritional factors may also influence musculoskeletal health.

Objective: To assess the prevalence of work-related musculoskeletal symptoms and examine their association with nutrient intake and nature of work among footwear industry workers.

Methods: A cross-sectional study was conducted among 122 workers aged 25–50 years in a small-scale footwear manufacturing unit in Ranipet, Tamil Nadu. Data were collected using a pre-tested semi-structured questionnaire incorporating the Nordic Musculoskeletal Questionnaire (NMQ). Information on demographic profile, anthropometric measurements, dietary intake (24-hour recall), and physical activity was obtained. Data were analyzed using descriptive statistics and the Pearson Chi-square test, with statistical significance set at $p < 0.05$.

Results: Musculoskeletal symptoms were prevalent among workers across various body regions. No significant association was found between nature of work and musculoskeletal symptoms ($p > 0.05$). However, significant associations were observed between protein intake ($p < 0.001$), calcium intake ($p < 0.01$), and magnesium intake ($p < 0.05$) with musculoskeletal symptoms. Nutrient intake analysis revealed considerable deficiencies in key nutrients among participants. Energy intake showed no significant association ($p > 0.05$).

Conclusion: The study highlights a high prevalence of musculoskeletal symptoms among footwear industry workers and emphasizes the role of nutritional factors, particularly protein, calcium, and magnesium, in musculoskeletal health. Improving dietary intake alongside occupational health strategies may help reduce the burden of musculoskeletal symptoms.

Keywords: Musculoskeletal symptoms, footwear industry, nutrient intake, occupational health

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) are one of the most common occupational health issues, characterized by injuries affecting muscles, nerves, tendons, joints, cartilage, or spinal discs. According to Rajarethinam et al. (2025), "musculoskeletal disorders have been characterized as injuries affecting muscles, nerves, tendons, joints, cartilage or spinal disks and conditions where the environment and the execution of tasks play a substantial role in the development of these conditions". These conditions result in symptoms like discomfort, pain, weakness which can also affect daily functioning and mobility (Geto et al., 2025).

According to a World Health Organization report (2022), approximately 1.71 billion people worldwide are affected by musculoskeletal disorders, with an estimated 50–70% occurring among workers across various occupations. The most common areas involved in MSDs are lower back, neck and shoulders which are not considered as life threatening but it affects the quality of life. Musculoskeletal symptoms usually develop gradually, but worsen with repeated exposures to workplace risk factors. Oftentimes, without ergonomic interventions or prevention approaches, symptoms can evolve

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into chronic debilitating conditions that further reduce both productivity and increase absenteeism (Nabi *et al.,* 2021; Kumaresan *et al.,* 2025)

Physical exposures such as repetition, awkward postures, force, and static loads have a major influence in WMSD. In cohort study, sewing machine operators were examined while seated in a static position and exposed to repetitive movements of upper-limb which elevated symptoms of shoulders and wrist (Kanniappan et al., 2020). Footwear artisans employed for long duration of squatting or bending received a high report of knee and lumbar disorders (Leite et al., 2021). Psychosocial risks related to demands, stress, long hour of work, and low control over job activities, are beginning to receive proper attention regarding the aggravation of WMSDs. Other research conducted among Brazilian manufacturing workers indicated perceived job stress and time pressure levels can magnify musculoskeletal symptoms experienced when physical exposures are present (Hembecker et al., 2017).

Hence, the study aimed to assess the baseline data, anthropometric status, dietary habits, and nutritional intake of footwear industry workers, and to evaluate musculoskeletal symptoms using the Nordic Musculoskeletal Questionnaire (NMQ). Furthermore, the study aimed to determine the relationship between nutrient intake and musculoskeletal symptoms, as well as to assess the association between the nature of work and musculoskeletal symptoms among footwear industry workers.

METHODOLOGY

The study was conducted in a small-scale footwear manufacturing unit, Jacs Halinsa, located in the Ranipet district of Tamil Nadu. The unit was selected based on the nature of work involving manual and semi-mechanized tasks, as well as the predominance of workers from lower socioeconomic backgrounds. The study was carried out over a period of six months (May 2025 to October 2025). A total of 122 workers aged 25–50 years, including both males and females engaged in cutting, stitching, assembly, and finishing sections, were selected based on voluntary participation and informed consent. Data were collected using a pre-tested semi-structured questionnaire incorporating the Nordic Musculoskeletal Questionnaire (NMQ) to assess musculoskeletal symptoms across nine anatomical regions. The questionnaire also included sections on demographic and socioeconomic details, anthropometric measurements (height, weight, body mass index, waist–hip ratio, and blood pressure), medical history, dietary habits (including a 24-hour dietary recall), and physical activity patterns.

The collected data were coded, entered into Microsoft Excel, and analyzed using SPSS version 27.0. Descriptive statistics (frequency, percentage, mean, and standard deviation) and inferential statistics (Pearson Chi-square test) were applied to determine associations between nutrient intake, nature of work, and musculoskeletal symptoms. Statistical significance was set at $p < 0.05$. All participants received personalized nutrition counselling in addition to guidance on yoga and basic exercises.

RESULTS AND DISCUSSION

1. Baseline information

The research involved a total of 122 people, including 57 men and 65 women. Most men were 20–30 years of age, while the largest group of women were 30–40 years of age. More women were married than men, which indicate that the vast majority of women were managing both work and home. In terms of education, men were more often diploma or ITI holders, while the majority of women were school-level graduates. Although very few of either group had college-level education, men were slightly more likely than women to have vocational training.

2. Work nature of the participants

The work nature of the participants were recorded and given in below table, which contributes to understand the work conditions that impact musculoskeletal health.

Most respondents belonged to the 1–5 years of work experience category, indicating a relatively young and less experienced workforce. The majority reported working 8–9 hours per day and 6 days per week, reflecting long working hours with limited rest. Most participants were engaged in sitting-type work, while a smaller proportion performed standing or repetitive tasks. Approximately half of the respondents reported experiencing physical strain, and a considerable proportion reported working overtime. In terms of commuting, most male participants traveled 1–6 km using two-wheelers, whereas female participants predominantly relied on walking or short-distance modes of transport. These findings states a moderately demanding work environment, where prolonged sitting and extended working hours may contribute to musculoskeletal strain and fatigue.

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Table 1
Work nature of the participants

S.No	Nature of work	Criteria	No of participants (n=122)	
			Male (n=57)	Female (n=65)
			No (%)	No (%)
1	Work Experience	< 1 Year	12 (21.1)	12 (18.5)
		1-5 Years	22 (38.6)	22 (33.8)
		5-10 Years	13 (22.8)	18 (27.7)
		>10 Years	10 (17.5)	13 (20)
2	Work Hours	<8 Hours	2 (3.5)	0 (0)
		8-9 Hours	48 (84.2)	64 (98.5)
		9-10 Hours	7 (12.3)	1 (1.5)
3	Work Days (Per Week)	5 Days	0 (0)	0 (0)
		6 Days	53 (93)	65 (100)
		7 Days	4 (7)	(0)
4	Nature Of Work	Standing	17 (29.8)	16 (24.6)
		Sitting	37 (64.9)	46 (70.8)
		Repetitive Movement	3 (5.3)	3 (4.6)
		Lifting Heavy Items	0 (0)	0 (0)
5	Regular Break	Yes	34 (59.6)	46 (70.8)
		No	23 (40.4)	19 (29.2)
6	Physical Strain	Yes	27 (47.4)	33 (50.8)
		No	30 (52.6)	32 (49.2)
7	Overtime	Yes	33 (57.9)	46 (70.8)
		No	24 (42.1)	19 (29.2)
8	Work Place – Home Distance	<1 Km	4 (7)	2 (3.1)
		1-3 Km	18 (31.6)	33 (50.8)
		4-6 Km	26 (45.6)	16 (24.6)
		> 6 km	9 (15.8)	14 (21.5)
9	Mode Of Transport	Walk	7 (12.3)	53 (81.5)
		Cycle	0 (0)	10 (15.4)
		Bus	17 (29.8)	1 (1.5)
		Two-Wheeler	33 (57.9)	1 (1.5)

3. Distribution of Participants by Job Description

The distribution of participants by job description helps identify occupational roles that are more prone to musculoskeletal problems. It enables comparison of symptom prevalence across different job categories to determine high-risk groups

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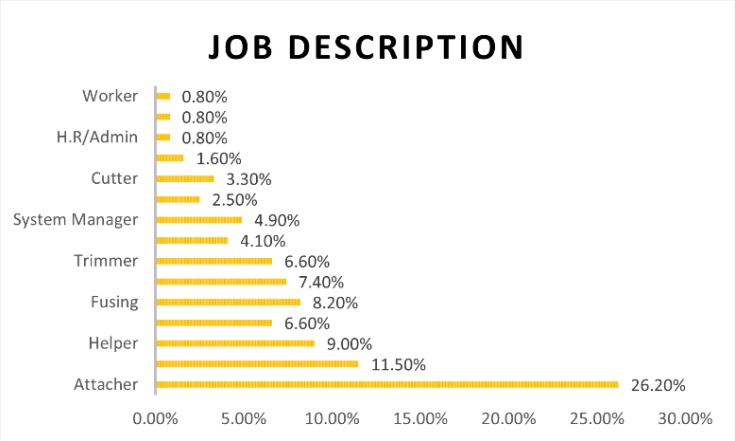

Figure 1. Distribution of Participants by Job Description (n=122)

According to Figure 1, the majority of respondents were employed as attachers (26.2%), followed by helpers (9.0%), fusing operators (8.2%), and trimmers (7.4%). The remaining participants were engaged as cutters, system managers, or administrative staff within the unit.

4. Anthropometric status based on BMI classification

The anthropometric profile of the participants shows that male workers had higher mean height and body weight compared to females; however, the mean BMI values were comparable between both groups (23.8 ± 3.18 kg/m² in males and 23.7 ± 5.4 kg/m² in females), proposing a similar overall nutritional status. The average BMI in both groups falls within the Asian "overweight" range, indicating a tendency towards increased body weight among the participants. Waist and hip circumference values were also relatively high in both males and females, with mean waist circumference exceeding recommended cut-off levels, signifying a risk of central obesity.

The waist–hip ratio (0.85 in both males and females) further specifies a borderline to increased risk of metabolic complications, particularly among female participants, where a ratio ≥0.85 is considered high risk. These findings highlight the presence of both generalized and central adiposity among the workers, which may contribute to an increased risk of musculoskeletal discomfort as well as metabolic disorders. Overall, the results emphasize the need for targeted interventions focusing on weight management, physical activity, and dietary modification to improve the health status of the study population.

The anthropometric status of the Participants based on Body Mass Index (BMI) using the WHO Asian cut-off values, providing insight into the prevalence of underweight, normal weight, overweight, and obesity were discussed below

Table 2
Anthropometric status based on BMI classification

S.No	Anthropometric Status	BMI Classification*	Number of Participants (N=122)			
			Male (n=57)		Female (n=65)	
			Mean ± SD		Mean ± SD	
			No	%	No	%
1	Underweight	Less than 18.5 kg/m²	0	0	8	12.3
2	Normal	18.5–22.9 kg/m²	40	70.2	34	52.3
3	Overweight	23.0–24.9 kg/m²	13	22.8	16	24.6
4	Obese	25 kg/m² or greater	4	7	5	7.7

* BMI Classification as per WHO Expert Consultation (2004) – Asian cut-off value

According to the WHO (2004) Asian BMI classification, the majority of participants were within the normal weight category, accounting for 70.2% of males and 52.3% of females. A considerable proportion of participants were classified as overweight (22.8% males and 24.6% females) and obese (7.0% males and 7.7% females). Notably, no male participants were underweight, whereas 12.3% of females fell into the underweight category. These findings indicate a

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mixed nutritional profile, with the coexistence of undernutrition and overnutrition, reflecting a double burden of malnutrition within the study population.

5. Lifestyle habits of the participants

The lifestyle habits of the participants were assessed to understand their health-related behaviors and existing medical conditions. This information provides insight into factors that may influence their overall health and risk of musculoskeletal problems.

Table 3
Lifestyle habits of the participants

S.No	Lifestyle Habits	Criteria	No of Participants (N=122)	
			Male (N=57)	Female (N=65)
			No (%)	No (%)
1	Medical History	None	31 (54.4)	36 (55.4)
		Diabetes	13 (22.8)	13 (20)
		Hypertension	11 (19.3)	14 (21.5)
		Asthma/Breathing Issues	1 (1.8)	1 (1.5)
		Joint Pain/ Arthritis	0 (0)	0 (0)
		Heart Disease	1 (1.8)	1 (1.5)
2	Sleep (6-8 Hours)	Yes	47 (82.5)	53 (81.5)
		No	10 (17.5)	12 (18.5)
3	Smoking Habit	Non-Smoker	44 (77.2)	65 (100)
		Occasional Smoker	6 (10.5)	0 (0)
		Daily Smoker	2 (3.5)	0 (0)
		Former Smoker	5 (8.8)	0 (0)
4	Alcohol Consumption	Never	34 (59.6)	65 (100)
		Occasional	11 (19.3)	0 (0)
		Regular	8 (14)	0 (0)
		Former Drinker	4 (7)	0 (0)

The lifestyle profile of the participants indicates that more than half of both males (54.4%) and females (55.4%) reported no history of chronic illness. Among the reported conditions, diabetes and hypertension were the most prevalent in both groups, recommending an emerging burden of non-communicable diseases among the workers. A majority of participants reported adequate sleep duration of 6–8 hours per day (82.5% males and 81.5% females), indicating relatively good sleep patterns, although a small proportion reported inadequate sleep, which may contribute to fatigue and musculoskeletal discomfort.

In terms of behavioral habits, most participants were non-smokers, with all female participants reporting no smoking, while a small proportion of males were occasional, daily, or former smokers. Similarly, alcohol consumption was observed only among male participants, with 40.4% reporting occasional to regular intake, whereas none of the female participants reported alcohol use. These findings highlight gender differences in lifestyle behaviors and suggest that while harmful habits are relatively low, the presence of chronic conditions and lifestyle risk factors may still contribute to overall health and musculoskeletal outcomes among the workers.

6. Prevalence of musculoskeletal symptoms among participants

The prevalence of musculoskeletal symptoms among the participants was assessed to understand the extent and distribution of discomfort across different body regions. This information helps identify commonly affected areas and the impact of these symptoms on work performance.

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Table 4
Prevalence of musculoskeletal symptoms among participants

S.No	Musculoskeletal Symptoms	Criteria	No of Participants (N=122)	
			Male (N=57)	Female (N=65)
			No (%)	No (%)
1	Musculoskeletal Pain	Yes	22 (38.6)	40 (70.2)
		No	35 (61.4)	17 (29.8)
2	Neck	Yes	22 (38.6)	11 (16.9)
		No	35 (61.4)	54 (83.1)
3	Shoulder (R&L)	Yes	19 (33.3)	28 (43.1)
		No	38 (66.7)	37 (56.9)
4	Elbows (R&L)	Yes	6 (10.5)	13 (20)
		No	51 (89.5)	52 (80)
5	Wrists/Hand (R&L)	Yes	13 (22.8)	15 (23.1)
		No	44 (77.2)	50 (76.9)
6	Upper Back	Yes	19 (33.3)	26 (40)
		No	38 (66.7)	39 (60)
7	Lower Back	Yes	22 (38.6)	31 (47.7)
		No	35 (61.4)	34 (52.3)
8	Hips/Thighs	Yes	11 (19.3)	30 (46.2)
		No	46 (80.7)	35 (53.8)
9	Knees (R&L)	Yes	15 (26.3)	27 (41.5)
		No	42 (73.7)	38 (58.5)
10	Anklets (R&L)	Yes	20 (35.1)	25 (38.5)
		No	37 (64.9)	40 (61.5)
11	Work Limitation	Yes	20 (35.1)	42 (64.6)
		No	37 (64.9)	23 (35.4)
12	Leave Taken	Yes	12 (21.1)	17 (26.2)
		No	45 (78.9)	48 (73.8)
13	Most Affected Region	Neck	13 (22.8)	3 (4.6)
		Shoulders (R&L)	11 (19.3)	19 (29.2)
		Elbows (R&L)	2 (3.5)	5 (7.7)
		Wrists/Hands (R&L)	3 (5.3)	3 (4.6)
		Upper Back	1 (1.8)	2 (3.1)
		Lower Back	9 (15.8)	14 (21.5)
		Hips/Thighs	3 (5.3)	6 (9.2)
		Knees (R&L)	8 (14)	8 (12.3)
		Anklets (R&L)	7 (12.3)	7 (10.8)
14	Medicine/ Treatment Taken	Yes	4 (7)	10 (15.4)
		No	53 (93)	55 (84.6)

The prevalence of musculoskeletal symptoms among the participants revealed a higher burden among female workers (70.2%) compared to males (38.6%), indicating gender-related differences in occupational strain and vulnerability. Among specific body regions, lower back pain was the most commonly reported symptom in both males (38.6%) and

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females (47.7%), followed by shoulder and upper back discomfort. Notably, females reported higher prevalence in most regions, particularly hips/thighs (46.2%), knees (41.5%), and shoulders (43.1%), whereas males reported comparatively higher neck pain (38.6%). Elbow-related symptoms were the least reported in both groups.

A considerable proportion of participants reported work limitations due to musculoskeletal problems, especially among females (64.6%) compared to males (35.1%), highlighting the impact of these symptoms on occupational performance. Although fewer participants reported taking leave or seeking medical treatment, the presence of untreated symptoms may contribute to chronic discomfort and reduced productivity. The most affected regions varied, with shoulders and lower back being prominent among females, while neck and lower back were more common among males. Najafi et al. (2023) states that the prevalence of these musculoskeletal discomforts leads to reduced work capacity and quality, increased medical costs, greater work time loss, and premature disability among workers. Therefore, these findings report a significant prevalence of work-related musculoskeletal disorders, emphasizing the need for ergonomic interventions, preventive strategies, and early management to reduce symptom severity and improve worker well-being.

7. Most affected body regions among the participants

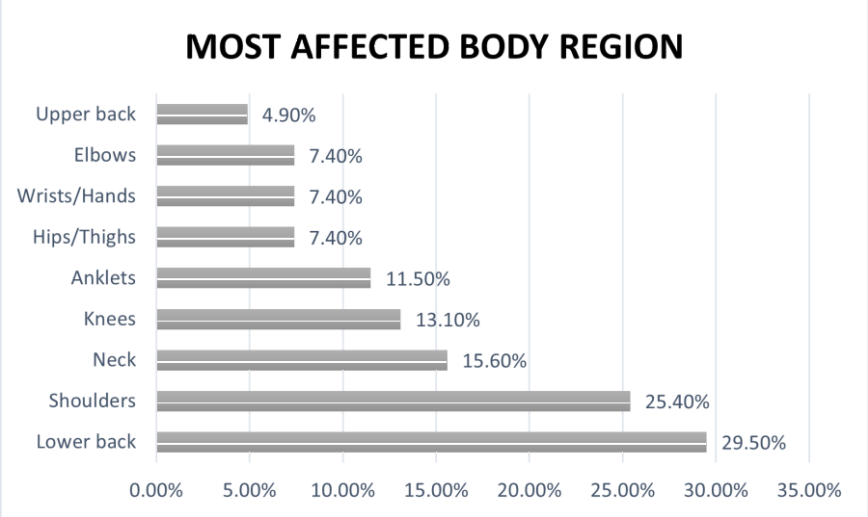

Figure 2. Most affected body regions among the participants

The distribution of musculoskeletal symptoms by body region point out that the lower back (29.5%) and shoulders (25.4%) were the most commonly affected areas among the participants. This may be attributed to prolonged sitting, repetitive movements, and poor ergonomic practices commonly observed in footwear manufacturing tasks. Neck pain (15.6%) and knee discomfort (13.1%) were also reported to a moderate extent, reflecting strain due to static postures and work-related physical demands.

In contrast, relatively lower prevalence was observed in regions such as anklets (11.5%), wrists/hands, elbows, and hips/thighs (each 7.4%), and upper back (4.9%). These findings put forward that musculoskeletal problems are predominantly concentrated in the upper and lower back regions, highlighting the need for targeted ergonomic interventions, posture correction, and workplace modifications to reduce strain and improve occupational health.

7. Dietary practices of participants

The Dietary practices of the participants reveal that the majority consumed three meals per day, with a higher proportion among females (95.4%) compared to males (82.5%), indicating relatively regular meal patterns. Daily breakfast consumption was also higher among females (81.5%) than males (57.9%), suggesting better adherence to healthy eating habits among female participants. However, a notable proportion of both males (42.1%) and females (18.4%) reported skipping breakfast, which may negatively impact energy levels and overall health. Intake of fruits and vegetables was found to be inadequate in more than half of the participants, highlighting a gap in the consumption of protective foods essential for maintaining health.

Junk and sugary food consumption was reported by a considerable proportion of participants, particularly among males (42.1%), which may contribute to poor dietary quality. Water intake patterns varied, with a substantial number of participants reporting moderate consumption (3–5 times per day), while a smaller proportion had low intake, especially

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among females. Diet adequacy perception differed notably between genders, with a majority of females (61.5%) being unsure about their dietary adequacy, whereas half of the males (50.8%) reported inadequate diets. The use of dietary supplements was minimal in both groups.

These results indicate suboptimal dietary practices, characterized by inadequate intake of fruits and vegetables, irregular meal habits among some participants, and low awareness regarding diet adequacy, emphasizing the need for targeted nutritional education and intervention.

8. Nutrient Intake of the participants

8.1 Nutrient intake of male participants

Table 5
Nutrient intake of male participants

S.No	Nutrients	RDA 2020	No of Male Participants (N=57)	Excess/Deficit
			Mean ± SD	
1	Energy (kcal)	2000	1466.05 ± 247.7	Deficit (26.7%)
2	Carbohydrate (g)	275	211 ± 21.2	Deficit (23.3%)
3	Protein (g)	52	33.5 ± 11.9	Deficit (35.6%)
4	Fat (g)	25	24 ± 2.12	Deficit (4%)
5	Fibre (g)	30	18 ± 2.46	Deficit (40%)
6	Calcium (mg)	1000	110.2 ± 57.7	Deficit (89%)
7	Magnesium (mg)	320	142.8 ± 44.5	Deficit (55.4%)

The nutrient intake analysis among male participants indicates a generalized inadequacy across both macronutrients and micronutrients when compared to the ICMR RDA (2020). Energy intake showed a deficit of 26.7%, suggesting insufficient caloric consumption to meet daily energy demands, which may negatively affect work performance, endurance, and overall productivity. Carbohydrate intake was also inadequate, with a deficit of 23.3%, indicating a reduced availability of primary energy sources required for sustained physical activity. Protein intake demonstrated a notable deficit of 35.6%, which may impair muscle maintenance, repair, and recovery, thereby increasing the risk of fatigue and musculoskeletal discomfort among workers.

Fat intake was relatively closer to the recommended level, with only a 4% deficit, suggesting near adequacy in this component of the diet. However, fibre intake showed a considerable deficit of 40% (⚠ correct this in your table: not “4(0%)”), indicating low consumption of fruits, vegetables, and whole grains, which may impact digestive health and overall diet quality. Among micronutrients, calcium intake exhibited a severe deficit of 89%, highlighting a critical gap that may adversely affect bone health and increase susceptibility to musculoskeletal disorders. Similarly, magnesium intake was deficient by 55.4%, which may contribute to muscle cramps, fatigue, and impaired neuromuscular function. The findings reveal that male participants have inadequate dietary intake, particularly of protein, fibre, calcium, and magnesium, which may aggravate musculoskeletal symptoms and reduce work efficiency. These results emphasize the need for targeted nutritional interventions, improved dietary practices, and awareness programs to enhance the nutritional status and occupational health of the workers.

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8.2 Nutrient intake of female participants

Table 6
Nutrient intake of female participants

S.No	Nutrients	RDA 2020	No of Female Participants (N=65)	Excess/Deficit
			Mean ± SD	
1	Energy (kcal)	1900	1235.8 ± 126.6	Deficit (34.9%)
2	Carbohydrate (g)	275	191 ± 18.40	Deficit (30.5%)
3	Protein (g)	46	33.64 ± 4.02	Deficit (26.9%)
4	Fat (g)	25	21.5 ± 3.62	Deficit (14%)
5	Fibre (g)	30	12.9 ± 2.61	Deficit (57%)
6	Calcium (mg)	1000	521.03 ± 94.3	Deficit (47.9%)
7	Magnesium (mg)	300	134.5 ± 47.80	Deficit (55.2%)

The analysis of nutrient intake among female participants revealed a marked inadequacy across most macronutrients and micronutrients when compared to the ICMR RDA (2020). Energy intake showed a deficit of 34.9%, indicating that a substantial proportion of participants were not meeting their daily caloric requirements, which may affect work capacity, endurance, and overall health. Similarly, carbohydrate intake was 30.5% below the recommended level, suggesting insufficient primary energy supply for physically demanding occupational tasks. Protein intake was also inadequate, with a deficit of 26.9%, which may compromise muscle maintenance, repair, and recovery, thereby increasing susceptibility to musculoskeletal discomfort. Fat intake showed a relatively lower deficit (14%), indicating that while fat consumption was closer to recommended levels, it may still be insufficient to meet total energy demands. A notable finding was the severe deficiency in fibre intake (57%), reflecting poor consumption of fruits, vegetables, and whole grains. Low fibre intake may not only affect gastrointestinal health but also indicates an overall poor-quality diet. Among micronutrients, calcium (47.9% deficit) and magnesium (55.2% deficit) intake were substantially low. These nutrients play a crucial role in bone health, muscle contraction, and neuromuscular function, and their deficiency may contribute to the high prevalence of musculoskeletal symptoms observed among the participants. The findings highlight a pattern of inadequate dietary intake among female workers, which may exacerbate occupational health risks, particularly musculoskeletal disorders. This underscores the need for targeted nutritional interventions, dietary education, and inclusion of nutrient-rich foods to improve both health status and work productivity.

9. Physical activity among the participants

Only a small proportion of participants engaged in regular physical activity, with 22.8% of males and 6.1% of females reporting consistent exercise. The majority did not follow any structured physical activity routine, indicating a predominantly sedentary lifestyle, particularly among female participants. This low level of physical activity, combined with prolonged sitting and suboptimal dietary habits, may contribute to the higher prevalence of musculoskeletal pain and increase the risk of lifestyle-related disorders among the study population.

10. Association between Work Type, Nutrient Intake and Musculoskeletal Symptoms

The association between nature of work, nutrient intake, and musculoskeletal symptoms was analysed using the Chi-square test. The consolidated results are presented in the table below.

Table 7
Association between Work Type, Nutrient Intake and Musculoskeletal Symptoms

Variable	χ^2 value	df	p-value	Interpretation
Nature of work	31.31	30	0.400	Not significant ($p > 0.05$)
Protein intake	33.07	6	<0.001	Highly significant ($p<0.001$)
Calcium intake	14.00	4	0.007	Significant ($p < 0.01$)
Magnesium intake	16.03	6	0.014	Significant ($p < 0.05$)
Energy intake	2.68	4	0.612	Not significant ($p > 0.05$)

Pearson Chi-square test was used to assess associations. Statistical significance set at $p < 0.05$.

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The present study assessed the association between nature of work, nutrient intake, and musculoskeletal symptoms among footwear industry workers. The results showed no significant association between nature of work and musculoskeletal symptoms ($p = 0.400$), indicating that musculoskeletal complaints were distributed across sitting, standing, and repetitive tasks without marked differences. This aligns with de Almeida et al. (2017), who also reported that certain body regions were not significantly influenced by occupational tasks. In contrast, nutrient intake showed a clear influence on musculoskeletal symptoms. A highly significant association was observed between protein intake and musculoskeletal symptoms ($p < 0.001$), indicating that inadequate protein intake may increase susceptibility to musculoskeletal discomfort due to reduced muscle repair and strength. Similarly, calcium ($p = 0.007$) and magnesium intake ($p = 0.014$) were significantly associated with musculoskeletal symptoms, highlighting the role of these micronutrients in bone health, muscle function, and neuromuscular regulation. These findings are supported by Mangano et al. (2017) and Liu et al. (2024).

However, energy intake showed no significant association ($p = 0.612$), indicating that total caloric intake alone may not directly influence musculoskeletal symptoms. The findings signifies that nutritional adequacy, particularly protein, calcium, and magnesium intake, plays a more important role in musculoskeletal health than energy intake or nature of work alone.

CONCLUSION

The present study revealed a high prevalence of work-related musculoskeletal symptoms among footwear industry workers. No significant association was observed between nature of work and musculoskeletal symptoms, indicating that discomfort was common across different job roles. However, significant associations were found between nutrient intake—particularly protein, calcium, and magnesium—and musculoskeletal symptoms, with higher prevalence among workers with inadequate intake. The study also identified considerable nutritional deficiencies among participants. These findings highlight that, in addition to occupational factors, nutritional adequacy plays an important role in musculoskeletal health. Therefore, integrating nutrition education with workplace health strategies may help reduce the burden of musculoskeletal symptoms among industrial workers.

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