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Assessment of ergonomic risk factors in the occurrence of work-related musculoskeletal discomfort & pain among cashew workers

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Abstract: Industrial workers, including cashew workers, often face work-related issues, including Pain, Musculoskeletal Discomfort (MSD) affecting muscles, joints, tendons, ligaments, and nerves. Work-related MSD (WMSD) & pain usually develop over time due to the nature of the work, environment, or machinery used. This study aimed to address that gap by identifying the intensity of pain and MSD among cashew workers, examining gender-based and task-specific differences, and highlighting the importance of joint protection, work simplification, and energy conservation techniques as preventive measures.

Methods: A cross-sectional survey was conducted among 40 cashew workers from Boovikanam and nearby areas in Kasaragod district, Kerala, who met the inclusion criteria. Data were collected using a convenient sampling technique. Standardised assessment tools, namely Rapid Entire Body Assessment (REBA) and Visual Analogue Scale (VAS), were used to evaluate WMSD and pain intensity. The data were analysed using IBM SPSS Statistics Version 26.

Results: Findings revealed a significant risk of WMSD among cashew workers, particularly during shelling and peeling activities. Most shelling workers demonstrated medium risk, while peeling workers demonstrated higher, very high-risk scores on REBA. Moderate pain intensity was common in both groups on the VAS. A significant positive correlation was observed between pain intensity and WMSD among male workers ($r = 0.725$, $p < 0.001$) and female workers ($r = 0.538$, $p = 0.014$), indicating that higher pain levels were associated with increased WMSD risk.

Conclusion: The findings highlight the need for ergonomic interventions, especially for workers with mild to severe pain. Gender differences were also observed; males commonly reported moderate pain, whereas females showed a wider range of pain intensities.Indexing Terms: Cashew Workers; Ergonomics; Pain; Survey Study; Work-Related Musculoskeletal Discomfort.

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Introduction

Musculoskeletal Discomfort (MSD) is a broad group of inflammatory and degenerative conditions affecting muscles, tendons, joints, ligaments, nerves, and other soft tissues that support movement. Work-related musculoskeletal discomfort (WMSD) has emerged as a major concern in both developed and developing countries, often caused by repetitive tasks, awkward postures, forceful exertions, and suboptimal ergonomic environments. This discomfort not only compromises the physical well-being of workers but also leads to reduced productivity, increased absenteeism, and higher compensation and healthcare costs. (1)

In India, the cashew industry is a major export sector, with Kerala alone accounting for 35% of processing units. Cashew processing is a labour-intensive, multistage process involving drying, roasting, shelling, peeling, grading, and packing, most of which are manually performed and physically demanding. Studies have consistently reported low back pain as the most prevalent symptom across various occupations. (2, 3)

A cross-sectional study among 246 cashew factory workers in Udupi district, Karnataka, found that 28.5% of workers experienced musculoskeletal pain, most frequently in the knees (32.4%), lower back (30.9%), and shoulders (11.8%). Cutting tasks were associated with the highest pain prevalence, and over 70% of affected workers had over five years of experience. (4, 5)

Despite the long-standing operation of cashew factories since the 17th century in South India, limited research has addressed the ergonomic risks and musculoskeletal implications for workers in this sector. Other regional studies report WMSD prevalence ranging from 28.5% to over 70% among various cashew processing tasks.6 Kerala-specific surveys highlight female gender and lower education levels as significant risk factors for MSD in this workforce. (7)

While ergonomic assessments and WMSD studies exist in other industrial settings, cashew workers remain underrepresented in the literature. This study aims to address that gap by identifying the intensity of musculoskeletal discomfort and pain among cashew factory workers, examining gender-based and task-specific differences, and highlighting the importance of joint protection, work simplification, and energy conservation techniques as preventive measures. The findings are expected to contribute to occupational health literature and inform ergonomic interventions and policies for this underserved workforce.

Methods

This study used a quantitative cross-sectional design to assess the intensity of work-related musculoskeletal discomfort (WMSD) among cashew workers. It was conducted in villages around Boovikanam, Kasaragod district, Kerala, approximately 10 - 15 km from Kasaragod town. Data collection aimed to provide various postures adopted during cashew work. A total of 40 cashew workers (20 males, 20 females), aged 35 - 55 years, were selected through convenient sampling due to accessibility and willingness to participate, and data were collected over a

period of two months, from May to June 2024. This age group was targeted as they are commonly engaged in physically demanding tasks in the cashew industry.

Inclusion criteria comprised workers involved in post-harvest cashew processing activities. Although cashew processing includes drying, roasting, shelling, peeling, and grading, the present study specifically focused on workers engaged in shelling and peeling tasks, as these activities are predominantly manual and ergonomically demanding. Drying, roasting, and grading processes were not included because these activities were largely mechanised in the selected processing units. Both literate and illiterate individuals were included.

Exclusion criteria covered those involved in other stages like cultivation or marketing, individuals recently ill, part-time workers, those with major neurological or orthopaedic issues, psychosocial distress, or unwillingness to participate. Data were collected using the standardised tools like Rapid Entire Body Assessment (REBA) and the Visual Analogue Scale (VAS).

The Rapid Entire Body Assessment (REBA) tool has demonstrated excellent intra-rater reliability (ICC = 0.925) and moderate inter-rater reliability (Fleiss' $\kappa = 0.54$), supporting its use as a reliable ergonomic assessment instrument for evaluating musculoskeletal disorder risk in occupational settings. (8)

The Visual Analogue Scale (VAS) is a highly reliable and valid instrument for subjective pain assessment, demonstrating excellent test–retest reliability with ICC values commonly reported above 0.90. (9)

REBA, developed by Hignett and McAtamney, is an ergonomic tool used to evaluate posture-related risk without needing specialised training or equipment. (10, 11) Scores were assigned to body regions (neck, trunk, upper limbs, legs), and final risk scores were calculated from task observations.

The REBA scoring system categorises ergonomic risk into negligible (score = 1), low (2 – 3), medium (4 – 7), high (8 – 10), and very high risk levels (11 – 15), with increasing scores indicating greater urgency for corrective action. (10)

VAS, a validated subjective scale, was used to assess pain intensity. It features a 10 – 15 cm line ranging from 0 (no pain) to 10 (worst pain), with visual cues to assist illiterate participants. Pain levels were categorised as no (0 – 1), mild (1 – 3), moderate (4 – 6), or severe. (12)

Descriptive statistics were used to determine WMSD and intensity, and inferential statistics assessed differences across gender and task categories. All methodological details were set before data collection; results are presented separately.

Results

A survey was conducted among 40 cashew workers in Kerala using a convenient sampling method. The data collected underwent extensive analysis using Statistical Product and Service Solutions version 22 (SPSS 22). Work-related musculoskeletal discomfort (WMSD) was assessed using the Rapid Entire Body Assessment (REBA) tool, and pain perception was measured through the Visual Analogue Scale (VAS). A questionnaire, interviews and observational methods were used to gather further information.

Descriptive statistics were used to analyse the frequency and percentage values of REBA and VAS scores. To examine the correlation between REBA and VAS among male and female cashew workers, the Pearson Correlation Coefficient (2-tailed) was applied. Since the data were normally distributed, the Pearson correlation was considered appropriate for analysis. (13)

Table 1 shows the mean and standard deviation of demographic data, such as age (43.50 + 5.43), REBA and VAS scores for Cashew workers, such as shelling and peeling workers.

Table 1: Description of Demographic Data

Variables		n	Mean ± Standard Deviation	Range
Age		40	43.50 ± 5.43	35 - 53
REBA	Shelling Work	20	7.10 ± 2.36	2 - 12
	Peeling Work	20	7.15 ± 3.31	2 - 12
VAS	Shelling Work	20	4.55 ± 1.87	1 - 8
	Peeling Work	20	4.50 ± 2.01	1 - 8

Table 2 shows the frequency and percentage of risk levels of Work-related Musculoskeletal discomfort through the REBA score for the cashew workers involved in shelling and peeling work. Results denote that the majority of the workers involved in shelling and peeling work had medium risk (i.e., 60% and 40%, respectively).

Table 2: Frequency and Percentage of Levels of Risk of WMSD as scored by Rapid Entire Body Assessment (REBA)

Risk Categories / Activities	Rapid Entire Body Assessment (REBA)									
	Negligible Risk (1)		Low Risk (2-3)		Medium Risk (4-7)		High Risk (8-10)		Very High Risk (11+)	
	f	%	f	%	f	%	f	%	f	%
Shelling Work	0	0	1	5	12	60	4	20	3	15
Peeling Work	1	5	3	15	8	40	3	15	5	25

Table 3 shows the frequency and percentage of levels of pain through the VAS score for the cashew workers. Both in shelling workers and peeling workers found moderate pain, i.e., 50% and 55% respectively.

Table 3: Frequency and Percentage of Pain of WMSD as scored by Visual Analog Scale (VAS)

Risk Categories / Activities	Visual Analog Scale (VAS)							
	No Pain (0)		Mild Pain (1 – 3)		Moderate Pain (4 – 6)		Severe Pain (7 – 10)	
	f	%	f	%	f	%	f	%
Shelling Work	-	0	6	30	10	50	4	20
Peeling Work	-	0	6	30	11	55	3	15

Table 4 shows the ergonomic risk factors / WMSD among 40 participants (20 males and 20 females). None of the participants had a negligible risk. Among males, 3 participants had low risk, 8 participants had medium risk, 2 participants had high risk, and 7 participants had very high risk. Among females, 2 participants had low risk, 12 participants had medium risk, 5 participants had high risk, and only one participant had very high risk. In total, 5 participants had low risk, 20 participants had medium risk, 7 participants had high risk, and 8 participants had very high risk.

Table 4: Comparison of REBA scores between male and female workers

Risk Categories / Gender	Rapid Entire Body Assessment (REBA)									
	Negligible Risk (1)		Low Risk (2-3)		Medium Risk (4-7)		High Risk (8-10)		Very High Risk (11+)	
	f	%	f	%	f	%	f	%	f	%
Male (n = 20)	-	0	3	15	8	40	2	10	7	35
Female (n = 20)	-	0	2	10	12	60	5	25	1	5

Table 5 shows the VAS pain level distribution among 40 participants (20 males, 20 females). None of the participants reported no pain (i.e., score: 0). Among males, 4 participants had reported mild pain (score: 1 - 3), 12 participants had reported moderate pain (score: 4 - 6), and 4 participants had reported severe pain (score: 7 - 10). Among females, 8 participants had reported mild pain, 9 participants had reported moderate pain, and 3 participants had reported severe pain. In total, 12 participants had reported mild pain, 21 participants had reported moderate pain, and 7 participants had reported severe pain.

Table 5: Comparison of VAS scores between male and female workers

Risk Categories / Gender	Visual Analog Scale (VAS)							
	No pain (0)		Mild Pain (1-3)		Moderate Pain (4-6)		Severe Pain (7-10)	
	f	%	f	%	f	%	f	%
Male (n = 20)	-	0	4	20	12	60	4	20
Female (n = 20)	-	0	8	40	9	45	3	15

Table 6 shows the correlation between VAS and REBA scores among 20 male cashew workers. A strong positive correlation (r = 0.725) was found, significant at p = 0.0001, indicating that higher pain levels (VAS) are linked to higher ergonomic risk (REBA) for male cashew workers.

Table 6: Correlation of REBA and VAS scores between Male Cashew Workers. (n = 20)

Variables	Mean (+ S.D)	r	df	p
VAS	4.70 (± 2.05)	0.725*	18	0.0001
REBA	7.70 (± 3.42)			
* Correlation is significant at 0.05 level				

Table 7 shows the correlation between VAS and REBA scores among 20 female cashew workers. A moderate positive correlation (r = 0.538) was observed, statistically significant at p = 0.014, indicating that higher pain levels (VAS) are moderately linked to greater ergonomic risk (REBA) for female cashew workers. As expected, both VAS and REBA show perfect self-correlation (r = 1).

Table 7: Correlation of REBA and VAS scores between Female Cashew Workers. (n = 20)

Variables	Mean (+ S.D)	r	df	p
VAS	4.35 (± 1.81)	0.538*	18	0.014
REBA	6.55 (± 2.03)			
* Correlation is significant at 0.05 level				

Discussion

The present study evaluated ergonomic risk factors, work-related musculoskeletal discomfort (WMSD), and pain intensity among cashew workers engaged in shelling and peeling activities. The findings demonstrated a considerable ergonomic risk of WMSD and pain among the workers, with significant correlations between REBA and VAS scores for both male and female

participants. These findings indicate that increased ergonomic risk of WMSD is associated with greater pain intensity among cashew workers.

The present findings are consistent with previous studies conducted among cashew-processing workers and other manual labour populations exposed to repetitive movements, awkward postures, and prolonged static work. Girish et al. reported that musculoskeletal pain was highly prevalent among cashew factory workers, particularly affecting the knees, lower back, and shoulders, with repetitive cutting and shelling activities identified as major contributing factors.4 Similarly, Chaitanya et al. observed that female cashew shelling workers experienced substantial musculoskeletal discomfort due to repetitive upper-limb movements and poorly designed workstations. (3) The current study further supports these findings, as most shelling workers demonstrated medium ergonomic risk, while peeling workers exhibited higher proportions of very high-risk REBA scores.

The elevated ergonomic risk of WMSD observed among peeling workers may be attributed to sustained neck flexion, repetitive wrist movements, prolonged sitting posture, and fine motor hand activities performed during peeling tasks. Similar ergonomic concerns were highlighted by Mallampalli et al., who identified awkward postures and repetitive hand-intensive activities as major predictors of WMSD among cashew-processing workers. (2) Another ergonomic intervention study by Mallampalli et al. demonstrated that workstation modification and ergonomic redesign significantly reduced REBA and RULA scores among cashew shellers, emphasising the importance of preventive ergonomic strategies in this sector. (14)

Pain intensity findings from the present study revealed that moderate pain was the most frequently reported category among both shelling and peeling workers. These findings correspond with Satheeshkumar's study among cashew industry workers in Kerala, which documented a high prevalence of musculoskeletal discomfort associated with repetitive occupational exposure and prolonged working duration. (7) Similar findings have also been reported in manufacturing and agricultural occupations, where repetitive manual tasks and sustained postures contribute significantly to musculoskeletal symptoms and pain development. (15)

Gender-based differences identified in this study are also supported by previous literature. Male workers predominantly reported moderate pain, whereas female workers demonstrated a broader distribution of pain intensity levels. Previous epidemiological studies have consistently shown that women report greater WMSD and severity of musculoskeletal pain than men. Picavet and Schouten found that musculoskeletal pain prevalence was systematically higher among women across multiple body regions. (16) Likewise, Treaster and Burr reported increased susceptibility of women to upper-extremity musculoskeletal disorders due to differences in biomechanics, muscle capacity, task allocation, and occupational exposure patterns. (17) The wider variation in pain intensity among female workers observed in the current study may therefore reflect biological, ergonomic, and psychosocial differences in occupational workload and pain perception.

A significant positive correlation was observed between REBA and VAS scores among both male ($r = 0.725$, $p < 0.001$) and female workers ($r = 0.538$, $p = 0.014$), indicating that higher ergonomic risk was associated with increased pain intensity. This finding reinforces the clinical

relevance of ergonomic assessment tools such as REBA in identifying workers at greater risk of developing WMSDs. Comparable findings have been reported in occupational ergonomic studies where increased postural risk scores were strongly associated with musculoskeletal pain severity and functional limitations. (1, 14)

> The present study contributes important evidence to occupational health literature, particularly in the context of the cashew-processing industry, which remains relatively underrepresented in ergonomic research. Unlike many previous studies focusing only on prevalence, the current study combined observational ergonomic assessment with subjective pain evaluation and gender-based comparison, thereby providing a more comprehensive understanding of occupational risk among cashew workers.

Despite these strengths, certain limitations should be considered. The cross-sectional design limits the ability to establish causal relationships between ergonomic exposure and WMSD. The relatively small sample size and convenient sampling technique may also restrict generalisability to larger populations of cashew workers. Additionally, psychosocial and organisational factors such as workload, job stress, rest breaks, and work environment were not assessed and may have influenced pain perception and ergonomic risk.

Overall, the findings emphasise the urgent need for ergonomic interventions within the cashew-processing industry. Strategies such as workstation redesign, posture correction training, scheduled rest breaks, task rotation, and education regarding joint protection and energy conservation techniques may help reduce WMSD risk and improve worker well-being. Gender-sensitive ergonomic approaches may also be beneficial considering the observed differences in pain distribution and ergonomic exposure between male and female workers.

Conclusion

In conclusion, the findings suggest that there is a high risk of WMSD among cashew workers. Also, the study findings indicate a clear trend where higher pain levels are associated with higher ergonomic risk of WMSD for both male and female cashew workers, also emphasising the need for ergonomic interventions, particularly for those experiencing mild to severe pain. This study's findings suggest gender-related variations in pain perception or reporting, with males more frequently reporting moderate levels of pain compared to females, who displayed a broader range of pain experiences.

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Limitations

This study focused solely on physical factors contributing to WMSD risk. Psychosocial aspects (e.g., workplace conditions, autonomy, monotony, work-rest cycle, task demands, social support) and individual factors (e.g., alcohol/tobacco use, stress) were not included. The study was limited to a single industrial worker group, limiting generalizability. Future research should include diverse farm settings to enhance applicability. Additionally, this study assessed only WMSD risk; further studies identifying actual MSD cases are recommended for effective intervention planning.

Ethical consideration

Informed and written consent was obtained from all participants. Ethical clearance was also obtained from Sri Sri University.

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