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Occupational Hazards And Worker Safety In Tea Plantations

A Comprehensive Analysis of Work Conditions and Health Risks among Women Tea Pluckers

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Abstract: In Assam, India's main tea-growing region, tea fields have historically depended on a largely female labour population that is subject to a number of occupational hazards. The physical working conditions, safety regulations, level of personal protective equipment (PPE), and managerial support for female tea pluckers were all examined in this study. Over half of 400 female tea pluckers who participated in a cross-sectional survey reported unfavourable working circumstances (54.70%), limited access to first aid (51.10%), and discontent with personal protective equipment (PPE) (54.80%). Additionally, over 70% of respondents mentioned musculoskeletal problems brought on by physically demanding occupations and repeated tasks.

Longer work exposure significantly increased health hazards, according to statistical studies such as chi-square tests, regression models, and Pearson correlation; on the other hand, enhanced safety perceptions and job satisfaction were strongly correlated with more managerial assistance. The results emphasise how urgently strong managerial reforms, efficient safety measures, and ergonomic improvements are needed. The report also examines possible future research directions, implementation challenges, and policy consequences.

Keywords: Tea plantations, occupational hazards, women tea pluckers, worker safety, ergonomic improvements, musculoskeletal disorders, personal protective equipment, safety training, managerial support, health risks.

I.INTRODUCTION

For more than a century, Assamese tea estates have been a vital part of the state's economy, contributing significantly to both local livelihoods and the world's tea production. On these estates, the majority of the labour-intensive tea plucking is done by women. These women continue to face subpar working circumstances despite the substantial economic contributions made by the tea business. They face numerous workplace hazards, such as excessive physical strain, inadequate safety measures, and a lack of managerial support.

Tea pluckers are women who perform physically demanding and repetitive tasks. Long periods of bending, repetitive hand motions, and moving heavy baskets over great distances are all part of the job. Chronic musculoskeletal issues arise as a result of the accumulated physical strain increased by these repetitive activities. Furthermore, a lot of tea gardens lack adequate safety facilities. Emergency first-aid services and high-quality personal protective equipment (PPE) are often unavailable to workers. These

challenges are made worse by the frequent lack of managerial assistance, which is exacerbated by the dearth of safety training and proper monitoring.

In addition to affecting immediate physical health, occupational problems in the tea plantation industry have significant socioeconomic repercussions. Chronic health issues among tea pickers can lead to long-term medical expenses, more absenteeism, and decreased productivity. The impact of these occupational dangers is further compounded by the gender-specific vulnerabilities of women in this industry, which include reduced social status, limited career progression opportunities, and unequal compensation.

The current study aimed to methodically investigate the safety circumstances and occupational dangers experienced by female tea pluckers in Assam, given the variety of these challenges. This study combined quantitative statistical analysis with a thorough review of the literature in order to identify important risk variables, evaluate the effectiveness of current safety measures, and provide evidence-based recommendations for improving worker safety. In order to contribute to the development of a safer and more sustainable working environment in the tea plantation sector, the study intends to provide important information to regulators and industry stakeholders.

II. METHODOLOGY

2.1 Population and Sample

Female tea pluckers employed at different tea estates in Assam, India, make up the study population. A sizable section of the workforce in Assam, one of the world's major tea-producing regions, is involved in manual tea plucking. Over 1.2 million people are employed in Assam's tea business, with women making up almost 70% of the workforce. These employees, who are mostly from low-income families, perform physically demanding jobs that expose them to a range of workplace risks.

To ensure that the sample was representative of different tea estates across districts, a stratified random sampling procedure was employed. The final sample consisted of **400 female tea pluckers** gathered from various plantations. Participants were chosen based on the following criteria: female tea pluckers with at least two years experience.

- Aged between 18 and 60 years.

- A willingness to engage in the study.

The stratified sample strategy assisted in gathering a broad range of respondents from small, medium, and big tea estates, resulting in thorough data collecting.

2.2 Data Collection and Sources

A standardized questionnaire was provided to participants during face-to-face interviews to gather primary data. The questionnaire includes both closed-ended and open-ended questions to collect quantitative and qualitative data. Data was collected for three months to reflect seasonal fluctuations in workload and occupational hazards.

Secondary data sources contained tea plantation management reports on worker safety and well-being.
- Government labour reports on Assam's occupational safety regulations.

- Existing research on ergonomic treatments and occupational health studies involving tea plantation workers.

Ethical considerations were adhered to throughout the data collection process. Each participant provided informed consent and their replies were anonymize to ensure confidentiality.

2.3 Theoretical Framework

The study follows the Job Demands-Resources (JD-R) Model, a framework for analysing occupational hazards and worker safety. This model is particularly relevant in understanding the relationship between workload, stress, and available workplace resources. The Job Demands refer to physical and psychological stressors associated with tea plucking, such as prolonged bending, lifting heavy baskets, and exposure to extreme weather conditions.

Furthermore, the Ergonomic Theory is applied to investigate workplace design and how poor ergonomic practices contribute to injury. Ergonomic improvements, such as redesigned tools and improved work postures, can reduce the incidence of repetitive strain injuries while increasing productivity. By applying these theoretical approaches, the study sheds light on how occupational dangers in tea farms affect worker well-being and job satisfaction.

2.4 Statistical Tools and Econometric Models

This section describes the statistical and econometric models used to analyse the data and draw appropriate conclusions. This methodology involves the following:

1. Descriptive Statistics

Descriptive statistics were employed to summarize demographic variables, work environment perceptions, and safety circumstances. Measures such as mean, standard deviation, frequency distributions, and percentages were computed to provide an overview of the collected data.

2. Chi-Square Test

The Chi-square test for independence was used to investigate the link between categorical factors such as work experience and the prevalence of musculoskeletal illnesses, or PPE availability and worker safety perceptions.

3. Regression Analysis

A multiple regression model was used to investigate the effects of independent variables such as managerial support, PPE quality, and ergonomic treatments on dependent variables such as worker safety perception and job satisfaction. The model equation is: $Y=\beta0+\beta1X1+\beta2X2+\beta3X3+\epsilon$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilonY=β0+β1X1+β2X2+β3X3+ϵ

- YYY represents worker safety perception.
- X1X_1X1 indicates managerial support.
  X2X_2X2 indicates PPE quality.
- X3X_3X3 represents ergonomic interventions.
- ϵ\epsilonϵ = error term.

4. Pearson Correlation Analysis

The Pearson correlation coefficient (r) was utilised to determine the association between safety measures and job satisfaction. A substantial positive association ($r > 0.7$) indicates that greater safety conditions lead to higher worker satisfaction.

5. ANOVA (Analysis of Variance)

To assess safety perceptions among various work experience groups, a one-way ANOVA test was used. This helped assess whether experienced workers perceive workplace hazards differently compared to newbies.
These statistical methods ensured robust data analysis, allowing for evidence-based findings and policy suggestions.

III. RESULTS AND DISCUSSION

A thorough examination of the information gathered from 400 female tea pluckers employed on Assamese tea farms is provided in the Results and Discussion section. Supported by statistical tests, correlations, and comparisons with prior research, this part examines the relationship among worker demographics, ergonomic concerns, occupational dangers, managerial support, and job satisfaction.
Examining the effects of age, work experience, and exposure to workplace risks on the health and well-being of employees is essential due to the physically demanding nature of tea plucking. Additionally, employee views of safety and general job happiness are greatly influenced by management support and safety training initiatives.

The study uses descriptive statistics to convey safety concerns and demographic variables in order to guarantee a thorough examination.
Chi-square tests are used to evaluate the connection between health hazards and work experience.

Regression analysis is used to assess how safety perceptions are impacted by managerial support and PPE availability.
To ascertain the impact of safety measures on job satisfaction, use Pearson correlation analysis.
Every subsection contains:
1. An overview of the information provided 2. A comprehensive table with statistical findings
3. Analysis and interpretation of the results
4. Evaluation against earlier research studies
5. Results justification and policy implications
This section offers evidence-based suggestions for enhancing occupational health, safety training, and worker well-being in tea plantations by examining the data gathered and using knowledge from earlier research on labour conditions and workplace safety.

The discussion is broken up into five main sections:
4.1 Worker Demographic Profile 4.2 Safety Issues and Occupational Hazards

4.3 Musculoskeletal disorders and ergonomic issues
4.4 Training and Support for Managers
4.5 Safety Measures and Job Satisfaction Correlation
In order to highlight the critical interventions required for a safer and more sustainable work environment in the tea business, each part presents statistical findings, talks about the reasons behind the results, and offers arguments based on earlier studies.

3.1 Demographic Profile of Workers

Understanding employees' demographic traits is essential to determining their long-term health outcomes, work efficiency, and vulnerability to occupational dangers. In tea plantations, factors including age, work experience, and physical stamina affect the risk of musculoskeletal problems, weariness, and production levels.
The physical demands of tea plucking include standing for extended periods of time, doing repetitive motions, and being exposed to harsh weather. Research has indicated that an employee's capacity to manage physical stress and occupational dangers is directly impacted by their age and years of experience (Kumar & Singh, 2016).

Table 1: Demographic Characteristics of Tea Plantation Workers

N=400

Demographic Factor	Categories	Percentage (%)	Mean ± SD	Statistical Test	p-Value
Age Range	18-30 years	30.34	34.6 ± 8.4	ANOVA (F=4.21)	0.032*
	31-45 years	50.12			
	46+ years	19.54			
Work Experience	Less than 5 years	25.67	10.8 ± 6.2	Chi-Square (χ^2=12.56)	0.041*
	6-15 years	44.89			
	More than 16 years	29.44			

Note: *p < 0.05 indicates statistically significant results.

According to the demographic data, 50.12% of tea pluckers are between the ages of 31 and 45, followed by 30.34% who are between the ages of 18 and 30 and 19.54% who are over 46. These results imply that middle-aged workers, who are in their prime working years and may be more susceptible to occupational health problems as a result of extended exposure to physically taxing duties, make up the core labour force on tea farms.

Comparably, the distribution of work experience shows that 44.89% of the employees had 6–15 years of experience, while 29.44% have been involved in tea plucking for more than 16 years, indicating prolonged exposure to occupational dangers. The idea that tea plucking is a labour-intensive job with a large proportion of career workers who are frequently subjected to tiredness, musculoskeletal disorders (MSDs), and repetitive motion injuries is supported by this data.

The ANOVA analysis (F=4.21, p=0.032) confirms that age has a statistically significant effect on work endurance, meaning that older workers are more susceptible to physical exhaustion and MSDs. Tea plucking requires continuous hand movements, standing for extended periods of time, and carrying heavy loads, all of which have a more severe effect on older workers than younger ones. This is corroborated by earlier research by Mehta et al. (2018), which found that employees over 40 exhibit higher ergonomic strain and need adjusted work environments.
Chi-square analysis indicates a significant correlation between exposure to occupational hazards and work experience (χ^2=12.56, p=0.041).

Workers with over 16 years of experience are more likely to suffer from chronic health conditions such as joint pain, fatigue, and repetitive strain injuries due to cumulative exposure to poor working conditions.This aligns with the findings of Kumar & Singh (2016), who identified a higher prevalence of MSDs among long-term workers in Assam's tea estates. Many workers remain in the tea industry for more than a decade, despite occupational hazards, because of limited alternative employment opportunities in rural areas.According to Roy (2015), economic dependency and low literacy levels often prevent workers from transitioning to less hazardous occupations.

3.2Occupational Hazards and Safety Concerns

Tea plucking is a high-risk work due to its repetitive nature, long standing hours, exposure to extreme weather conditions, and lack of adequate protective equipment. Workers are regularly exposed to physical strain, musculoskeletal diseases, bug bites, chemical exposure (via pesticides), and occupational injuries.
Ensuring suitable safety measures, such as access to personal protective equipment (PPE), first aid facilities, and effective workplace policies, is critical for decreasing occupational dangers. However, safety compliance is lacking on many tea farms, resulting in greater rates of injuries and work-related diseases

(Sharma & Verma, 2017).
The table below summarises employees' perceptions on job dangers and safety concerns.

Table 2: Occupational Safety Concerns Among Workers

N=400

Safety Concern	Percentage (%)	Mean ± SD	Statistical Test	p-Value
Workers feeling unsafe	54.70	1.42 ± 0.63	Chi-Square (χ^2=14.87)	0.038*
Inadequate first aid access	51.10	1.52 ± 0.59	Chi-Square (χ^2=11.32)	0.042*
Dissatisfaction with PPE	54.80	1.47 ± 0.61	Chi-Square (χ^2=15.20)	0.036*

Note: ***p < 0.05 indicates statistically significant results.***

More than half (54.70%) of tea pluckers reported feeling unsafe at work, indicating a lack of effective safety measures and enforcement of workplace policies.51.10% of employees said they did not have enough access to first aid supplies, which raises the possibility of problems from accidents at work. 54.80% of respondents expressed dissatisfaction with the PPE's quality, citing uncomfortable, inadequately maintained, or unavailable equipment.The findings of the chi-square test verify that worker safety concerns differ considerably depending on job experience, estate location, and management style.
A statistically significant correlation between inadequate safety conditions and feeling uncomfortable at work is confirmed by χ^2=14.87, p=0.038.

Many tea estates place a higher priority on output than the welfare of their employees, which results in little investment in adequate safety equipment and first aid supplies. Our findings are corroborated by studies by Sharma & Verma (2017), which discovered that PPE was either insufficient or unavailable in 80% of tea plantations.
Employees expressed a lack of knowledge of safety procedures, primarily as a result of managers' and supervisors' inadequate training. According to Table 4, just 30% of employees have received any safety training, which restricts their capacity to manage risks at work.Because of discomfort, a lack of replacements, or a lack of supervisor enforcement, workers frequently did not utilise basic personal protective equipment (PPE) even on plantations that offered it.

Workers on farms with rigorous PPE enforcement saw 40% fewer accidents than those where compliance was discretionary, according to Mehta et al. (2018).
To reduce health hazards, tea farms must purchase premium PPE, such as ergonomic plucking baskets, back support belts, and gloves. According to Das & Bose (2019), using ergonomic personal protective equipment (PPE) decreased occupational injuries by 25%. All employees should be required to complete first aid training in order to enhance their ability to respond to incidents at work.There is a pressing demand for on-site medical supplies because over 50% of employees do not have access to first aid.

The need for improved safety monitoring by estate managers was emphasised by Roy (2015), who discovered that workplaces with good managerial oversight experienced a 30% decrease in injuries.

3.3 Problems with Ergonomics and Musculoskeletal Conditions

Because tea plucking entails heavy lifting, extended standing, bending, and repeated hand movements, musculoskeletal disorders (MSDs) are common among workers. In tea plantations, MSDs—such as joint discomfort, back pain, and repetitive strain injuries—are among the most often reported health problems.The frequency of MSDs and ergonomic problems among tea plantation workers is summarized in

the following table.

Table 3: Workers' Musculoskeletal Disorder (MSD) Prevalence

N=400

Musculoskeletal Disorder	Percentage (%)	Mean ± SD	Statistical Test	p-Value
Back pain (bending posture)	70.00	2.91 ± 1.12	Chi-Square (χ^2=18.23)	0.021*
Repetitive strain injuries in hands	65.00	2.73 ± 1.08	Chi-Square (χ^2=14.65)	0.034*
Difficulty carrying heavy loads	45.00	2.54 ± 0.97	Chi-Square (χ^2=12.92)	0.041*

Note: ***p < 0.05 indicates statistically significant results.***

The most common ergonomic problem is persistent back discomfort, which 70% of employees reported having as a result of extended bending. Due to constant plucking actions, 65% of people suffered from repetitive strain injuries, especially in the hands, wrists, and shoulders.Forty-five percent of those who worked long shifts said they had trouble lifting large items, especially tea baskets.The findings of the chi-square test show a strong correlation between the prevalence of MSDs and job experience.It is confirmed by χ^2=18.23, p=0.021 that back pain is very common among seasoned workers. χ^2=14.65, p=0.034 indicates that worker productivity is greatly impacted by repetitive strain injuries.

Employees that pick tea leaves for eight to ten hours a day may sustain overuse injuries to their hands, wrists, and shoulders. According to Sharma & Verma (2017), employees who engaged in repetitive jobs for more than six hours a day were 60% more likely to acquire MSDs. The weight and poor construction of traditional tea baskets put additional strain on the shoulders and back.

According to Mehta et al. (2018), back strain was decreased by 35% by altering tea plucking baskets, highlighting the significance of ergonomic treatments.The majority of tea farms do not offer enough rest periods, which causes ongoing stress on the joints and muscles. According to research by Das & Bose (2019), adding rest periods and job rotation decreased MSD complaints by 40%. Tea baskets that are lightweight and ergonomically built ought to be introduced in order to lessen shoulder and back strain. Employees that used ergonomic tools had a 50% lower rate of MSDs, according to Kumar & Singh (2016).

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3.4 Managerial Support and Training

Structured training programs and managerial support are essential for maintaining worker safety and lowering occupational dangers. Access to ergonomic tools, safety training, and supervisor involvement are essential for reducing workplace hazards and increasing productivity.
Plantations with regular training programs and effective managerial control report lower job injuries and higher worker satisfaction, according to several studies (Roy, 2015; Sharma & Verma, 2017). The availability of training programs and the degree of managerial support in tea plantations are examined in this section.

Table 4: Managerial Support and Training Programs

N=400

Managerial Factor	Percentage (%)	Mean ± SD	Statistical Test	p-Value
Workers receiving formal safety training	30.00	1.82 ± 0.79	Chi-Square (χ^2=10.42)	0.048*
Supervisors addressing safety concerns adequately	40.00	1.95 ± 0.82	Chi-Square (χ^2=12.65)	0.039*
Availability of ergonomic tools	55.00	2.12 ± 0.74	Chi-Square (χ^2=15.78)	0.028*

Note: ***p < 0.05 indicates statistically significant results***.

Only thirty percent of tea pluckers reported having received official safety training, indicating a serious lack of occupational preparation.
There is a lack of administrative participation in worker safety, since 40% of respondents believe their superiors handle safety issues appropriately.
55% of respondents concurred that there are ergonomic items on the market, but insufficient training usually prevents them from being used effectively.
The idea that there is a considerable correlation between managerial engagement and workplace safety is supported by chi-square results. Employee safety views are significantly impacted by supervisor engagement, as shown by χ^2=12.65, p=0.039.
Access to ergonomic tools is positively correlated with reduced injury rates (χ^2=15.78, p=0.028).

Supervisors frequently put productivity ahead of safety, which leads to lax enforcement of safety regulations.
According to Roy (2015), MSD complaints were twice as common in workplaces with inadequate managerial monitoring as in plantations with adequate supervision.
Although 55% of respondents stated that ergonomic equipment were available, the majority lacked training on how to use them properly, which decreased their usefulness.

According to Sharma and Verma (2017), musculoskeletal diseases decreased by 30% in workplaces with ergonomic training.

3.5 Correlation Between Safety Measures and Job Satisfaction

Worker safety and job satisfaction are inextricably intertwined, as improved safety conditions lead to higher job satisfaction, lower absenteeism, and enhanced productivity. Providing adequate personal protection equipment (PPE), ergonomic interventions, and managerial support can greatly improve worker morale and well-being.
Sharma and Verma (2017) discovered that tea plantation workers who felt safer at work had a 30% reduced turnover rate, highlighting the significance of workplace safety in employee retention. Similarly, Roy (2015) found that increased safety measures resulted in higher worker performance and fewer work-related health issues.
To investigate this association, a Pearson correlation test was performed on safety metrics and worker job satisfaction. The findings are summarised in Table 5.

Table 5: Correlation Analysis of Safety Measures and Job Satisfaction

N=400

Variable	Correlation Coefficient (r)	p-Value	Statistical Significance
Availability of PPE & Job Satisfaction	0.68	0.014	Significant ($p < 0.05$)
First Aid Facilities & Job Satisfaction	0.72	0.009	Significant ($p < 0.01$)
Managerial Support & Job Satisfaction	0.77	0.006	Highly Significant ($p < 0.01$)

Note: $p < 0.05$ indicates statistically significant correlation, $p < 0.01$ indicates highly significant correlation.

There is a high positive association ($r = 0.68$, $p = 0.014$) between the availability of PPE and job happiness, indicating that workers who have access to suitable safety equipment feel more comfortable and pleased at work.

First aid facility access correlates even more strongly with job satisfaction ($r = 0.72$, $p = 0.009$), implying that timely access to medical care boosts worker trust in workplace safety.

The highest association ($r = 0.77$, $p = 0.006$) exists between managerial assistance and job satisfaction, indicating that employees who receive proactive monitoring, training, and problem resolution are more likely to be content with their positions.

The Pearson correlation coefficients (r) vary from 0.68 to 0.77, indicating a substantial positive association between safety measures and job satisfaction.

Low p-values ($p < 0.01$) show significant associations, excluding randomness. Protecting workers from injuries reduces stress, leading to improved job performance and happiness. Mehta et al. (2018) discovered that workers who had consistent PPE availability reported 25% higher workplace engagement.

Supportive managers increase employee retention rates by making them feel valued and motivated. Das and Bose (2019) discovered that plantations with high managerial engagement had 30% fewer worker resignations due to improved working conditions.

Quick access to medical care promotes workplace safety and minimises fear of injury. Sharma and Verma (2017) found that tea farms with specialised medical facilities received 40% fewer workplace complaints about safety concerns.Estates should guarantee that high-quality personal protective equipment (PPE) is provided and routinely maintained.Roy (2015) discovered that plantations with enforced PPE laws experienced a 20% boost in worker efficiency.Providing 24 hour first aid access and qualified first responders can dramatically boost workplace trust.Mehta et al. (2018) discovered that plantations with on-site medical staff had a 35% reduced absence rate.Supervisors should be trained to proactively address safety problems and improve worker relations.Das & Bose (2019) discovered that plantations that implemented safety leadership programs witnessed a 50% increase in worker satisfaction levels.

CONCLUSION

This study examines occupational hazards, ergonomic risks, management support, and job satisfaction among female tea pluckers in Assam. The findings indicate serious gaps in workplace safety measures, access to protective equipment, and training programs, all of which have a significant influence on worker health and satisfaction.

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