



Ergonomic Study of Work-Related Musculoskeletal Disorders Among the Female Tea Pluckers- A Review

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Abstract

Musculoskeletal Disorders (MSDs) are a major cause of disability, lost work time, and economic loss in both developed and developing countries. Muscle, bone, joint, nerve, and blood vessel disorders are all examples of MSDs. This research looks at the role of ergonomic tools in detecting MSDs, and ergonomic interventions in reducing problems and musculoskeletal injuries among female tea garden workers. The review of literature summarizes various problems and risk factors associated with tea plucking activity such as incorrect techniques, repetitive work, long duration of work, awkward plucking postures, forward bending, high exertion of work, prolonged static posture, manual cutting of leaves, carrying of heavy load, working in high temperature and relative humidity during work and different methods and supportive tools e.g., REBA, RULA, OWAS, SNQ, OCRA, etc. to detect the risk. All of these issues contribute to musculoskeletal injuries, particularly in the lower back, neck, buttock, thigh, and knee joints. Musculoskeletal symptoms such as muscle pain, and muscle cramps, are common among tea garden workers. The paper concludes that ergonomic interventions can reduce problems and musculoskeletal injuries among female tea pluckers.

Key words : Musculoskeletal Disorders (MSDs), Tea Pluckers, Ergonomics

Introduction

North Bengal, region is on the foot of the Himalayas, traditionally known for its tourism, timber, and most importantly tea industries. Small tea cultivation belongs to the informal or unorganized sector of the economy. Small Tea Growers (STGs) of North Bengal are mainly spread over Jalpaiguri, Darjeeling, Uttar Dinajpur, and some parts of Coochbehar district beside large tea estates. (Choudhury et al, 2019). According to the 66th Annual report of the tea board of India: 2019-20, there is a total of 37365 STGs covering 33711.27 hectares of tea plantation area in West Bengal which directly or indirectly creates jobs for people. Due to the reduction of labour costs, tea companies ignore their responsibilities like health, safety, working conditions, proper training, ergonomic tools, etc. for the workers.

From the unorganized sector, half of our country's GDP is earned. According to National Sample Survey (NSS) report in the year 2017-2018, in India, approximately 81% workforce is from the unorganized sector while 19% are from the organized sector (NSS, 2021). Unskilled, untrained workers involve with unorganized sectors, and skilled or trained workers are involved with organized sectors. Poverty is more prevalent among those associated with the unorganized sector due to a lack of technology and marketing strategies. Since a mass workforce is working in these sectors, prior importance should be given so as to improve the conditions of the workforce (Satpathy et al, 2017).

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India's tea industry is one of the country's oldest and largest job providers. There are permanent, contractual, temporary, and seasonal workers who have all been employed in this business (Gothoskar, 2011). The tea industry in India is increasing day by day. Small tea growers' production was 1.16% in 1999 but now according to the 66th annual report 2019-2020, of the Tea Board of India, small tea growers share 49.24% of total production (Tea Board of India, 66th annual report 2019-2020).

Tea laborers, often known as "Adivasis," who moved from states like Orissa, Jharkhand, and Bihar decades ago have permanently lived in and around the estates (Sarman et al, 2019). Small tea growers set a minimum quantity of leaves to be plucked, which varies by hamlet and garden size (Kumar, 2020). Labourers are paid based on the amount of tea harvested per day or the amount of time they spend working. Additionally, workers are paid an incentive wage if they pluck more leaves than their daily quota (Kumara et al, 2020).

Since the beginning of the tea industry in India women have worked as tea pluckers. In tea plucking tasks over 80% are women workers (Gothoskar, 2011). Women in tea industries are paid less compared to male workers for doing the same job (Dutta, 2015). Due to easy availability and low pay negotiating capability among women employees, small tea growers of North Bengal appointed more female workers for tea plucking, cleaning, and pruning (Kumar, 2020).

Their Problem with reference to MSD

Tea plucking is primarily a female-dominated occupation. During work time, without concern about health, in India tea pluckers are still used the conventional method of tea plucking by carrying a basket or hanging a bag from their head in the same position for a long time. This leads to work-related musculoskeletal disorders (Chakraborty et al, 2021). Working in the same posture for a long time causes discomfort in different parts of the body. This posture is familiar with tea pluckers, as they work long hours in the same extension while picking tea leaves, resulting in musculoskeletal disorder. Different causative factors of MSDs among the tea worker include imperfect ergonomic design in the atelier, routine repetitive work, recurrent bending, twisting, lifting, and forceful movements (Masri et al, 2017). Apart from these, there are other factors like age, sex, anthropometric, muscle strength, physical fitness, variation in the task, lack of rest break, and social factors that leads to musculoskeletal disorders (Gardner et al. 2002).

According to the International Labour Organization (ILO), there are approximately 160 million work-related diseases worldwide each year. WMSDs (work-related musculoskeletal diseases) are important in terms of both occupational health and the economy (Niu, 2010). Long reach work like working overhead, and bending over to reach a part in the bottom usually has the greatest impact on the shoulders and lower back, which can result in an ergonomic injury (Hakkanen et al, 2001). On a tea plantation, female pluckers had a high rate of absenteeism because of growing age- and work-related illness (Kumara et al, 2020). Because of the repetitiveness and static uncomfortable position, many of the operations, particularly the plucking activity conducted by the workers, require a high degree of physical effort, leading to early weariness and work-related musculoskeletal disorders. That's why ergonomically redesigning the existing baskets is necessary based on anthropometric data of tea plucker (Gangopadhyay et al, 2014).

MSD is a painful disorder caused by repetitive use of the locomotive apparatus of the human body (muscle, nerve, tissue, tendon) in the workplace. It is considered a costly disorder because it affects human health and reduces productivity at the workplace. It is also called a multifactorial disorder because there can be different factors like mechanical overload, repetition frequency, exposure time, posture, and accident, which are responsible for MSD (Das et al, 2020). Approximately 1.71 billion people worldwide have musculoskeletal disorders, among these disorders, low back pain has a high prevalence in 568 million people worldwide. Rapid population increase, the unhealthy environment in the workplace, and aging are responsible for the occurrence of MSD (Hartvigsen et al, 2018 and Cieza et al. 2020).

In India use of machines is not common. They prefer either basket or bag hanging from the Plucker's head. The load directly transmits the weight through the neck to the lower back. Tea Plucking in this situation for a long time causes pain in the shoulder. This leads to long-term MSD in the neck-shoulder region (Masri et al, 2017). A

similar 12 months study by Masri et al, 2017 and Vasanth et al, 2015 on tea pluckers of Malaysia and India showed that the prevalence of MSDs on the wrist and knee was similar but the prevalence of lower back pain was high on tea pluckers of India than tea plucker of Malaysia. This is possible because in Malaysia tea pluckers use machines for tea plucking, whereas Indian tea pluckers use conventional methods by carrying a basket or bag at the back of the workers which is responsible for lower back pain in tea pluckers India (Bhattacharyya et al, 2012). Long-term MSD particularly persists for more than 1 month in the lower limb and neck-shoulder which is common in both the worker of Malaysia and India (Vasanth et al, 2015 and Osborne et al, 2010).

Ergonomic as a tool to detect disease

According to Dul et al, 2009, Ergonomics is a branch of science concerned with learning about human characteristics and perception of optimizing human well-being by adopting different theories, principles, data, and methods. The aim of ergonomics in the workplace is to reduce MSDs and increase productivity.

According to World Health Organization (WHO), musculoskeletal Disorders can be measured in terms of problems associated with them, such as pain, ache, discomfort, numbness, or disability, or in relation to the cause, such as joint disease or trauma. Women who are underweight, overweight, or had a pallor have a higher risk of musculoskeletal diseases. However, in a univariate logistic regression study, only being overweight was a statistically significant predictor of musculoskeletal diseases. Elbow and low back pain appear to be more chronic, having a high prevalence of occurrence (Chakraborty et al, 2021).

Furthermore, ergonomic treatments are a good approach to preventing ergonomic work-related problems, especially when ergonomic considerations involve tool design and educational programs. Indeed, the ultimate conclusion of the study emphasizes the need for ergonomic intervention through ergonomic instrument design. (Naeini et al, 2014).

Ergonomical assessment tools

There are different methods for assessing and/ or preventing the risk of MSDs.

RULA

RULA tool provides a simple way to evaluate a working population for possible exposure to work-related Upper limb disorder. RULA is a very simple technique to measure postural discomfort. In this tool, the body was suspended into two parts that formed two groups: group A and B, in order to create quick to use technique. The upper and lower arm, as well as the wrists, are in group A, whereas the neck, torso, and legs are in group B. This ensures that the whole-body posture is recorded including any uncomfortable or constructed posture of the legs, trunks, or neck that might impact the posture of the upper limb. The range of movement of different body parts of group A and B is measured to get the Final RULA score. (McAtamney et al, 1993, Nelfiyanti et al, 2022)

REBA

REBA was developed for evaluating tasks that need both dynamic or static posture as well as workplaces with significant variations in work postures (Soheili-Fard et al, 2017). It is an ergonomic approach that is used to swiftly analyze an operator's work posture of the neck, back, arm, wrists, and leg. The REBA assessment is quick and easy to use and it provides a general score on a list of tasks that indicate the need for risk reduction due to the operator's work posture (Muhammad et al, 2018). Different part of the body is categorized into categories using this method with 72 posture combination, Group A is focused on the trunk, neck, and legs and with 36 posture option, group B is concerned with upper arms, lower arms, and wrist (Soheili-Fard et al, 2017). By calculating the range of movement of the above-mentioned extremities, the final score can be obtained by the REBA worksheet and can identify the level of risk by comparing REBA standard scale (Hignett et al, 2000. Nelfiyanti et al, 2022).

Most postural analysis approaches have two qualities: generality and sensitivity which are typically at odds (Fransson-Hall et al, 1995). Ovako working posture analysis offers a wide range of applications but the results might be lacking in details (Hignett et al, 2000).

National institute for occupational safety and health (NIOSH) on the other hand, demands precise information on specific characteristics of the posture in order to provide high sensitivity with regard to the stated indices but has

limited use in health care, particularly in the area of active load management. The need for tools with sensitivity in healthcare and other sector becomes essential. This leads to the creation of REBA (Hignett et al, 2000).

The Ovako working posture assessment system (OWAS) tools were first used in Finland by the OVAKO OY company. This method was designed to determine the frequency and length of time spent in various postures while performing a task, as well as to analyze and assess the issue and as a result offer solution (Gómez-Galán et al, 2017, Nelfiyanti et al, 2022).

OWAS tool is divided into two parts: the first part is an observative methodology for assessing work position in the daily work routine and the second part is the creation of criteria for redesigning work postures and obtaining dependable results after completing the basic OWAS training when performing manual material handling operations. A four-digit code is used to indicate the back arm leg and weight in a sequential manner (Ramadhani et al, 2018, Entringer et al, 2018).

SNQ

The standard Nordic Questioners pr SNQ for short is a tool for determining which region of the muscle has complaints, with the level of pain ranging from no pain, mild pain, and high pain. This questionnaire is already recognized and validated globally and is used to diagnose symptoms in the body area, such as shoulders, neck, back, and other extremities (Ginting et al, 2019).

The aim of this questionnaire in the context of ergonomics is the screening musculoskeletal problem and improve occupational health (Kuorinka et al, 1987).

OCRA

The occupational repeated activities is a single figure synthetic index that describes risk variables for repetitive action at work (Roman-Liu et al, 2013). It is derived as a ratio of the foreseeable frequency (FF) of technical activities per minute to the comparable number of suggested actions referred to as the referas frequency (RE). It is one of the most advanced quantification systems, claiming to obtain accuracy by accumulating detailed assessments. The final score determines the overall risk of MSD, however, it does not look into the reasons or suggest ways to improve. All these facts make it a quantification tool.

Objective

The purpose of this study is to identify the musculoskeletal risk associated with different postures during tea plucking and different ergonomic methods used to detect the postural risk.

Research methodology

The research design is descriptive in nature. For that, a review of Literature was done in order to identify the problems, risk factors, and injuries prevailing among the tea plucker and relevant ergonomic interventions. The articles were retrieved from search engines Google Scholar, ResearchGate, and PubMed by mentioning keywords such as ergonomics, the musculoskeletal disorder of Tea plucker, ergonomic interventions, and methods used in ergonomics.

Review of literature and findings

This research study compiles publications on minimizing tea pluckers' issues and injuries through ergonomic treatments, with an emphasis on the role of ergonomics in enhancing tea workers' productivity and efficiency.

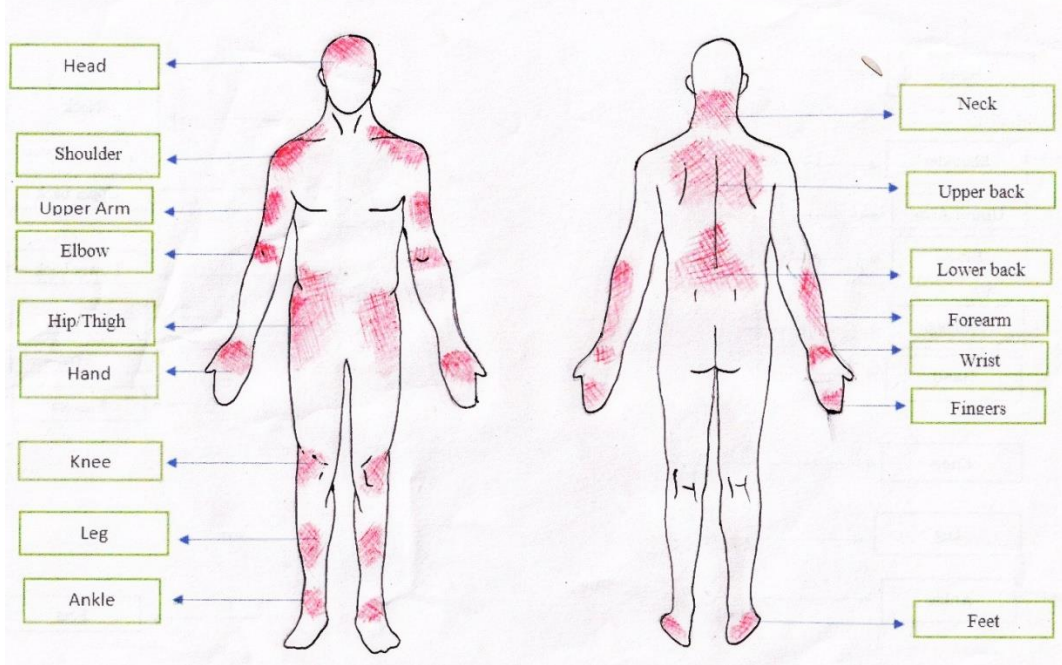


Figure1: Different postural problem (Male)

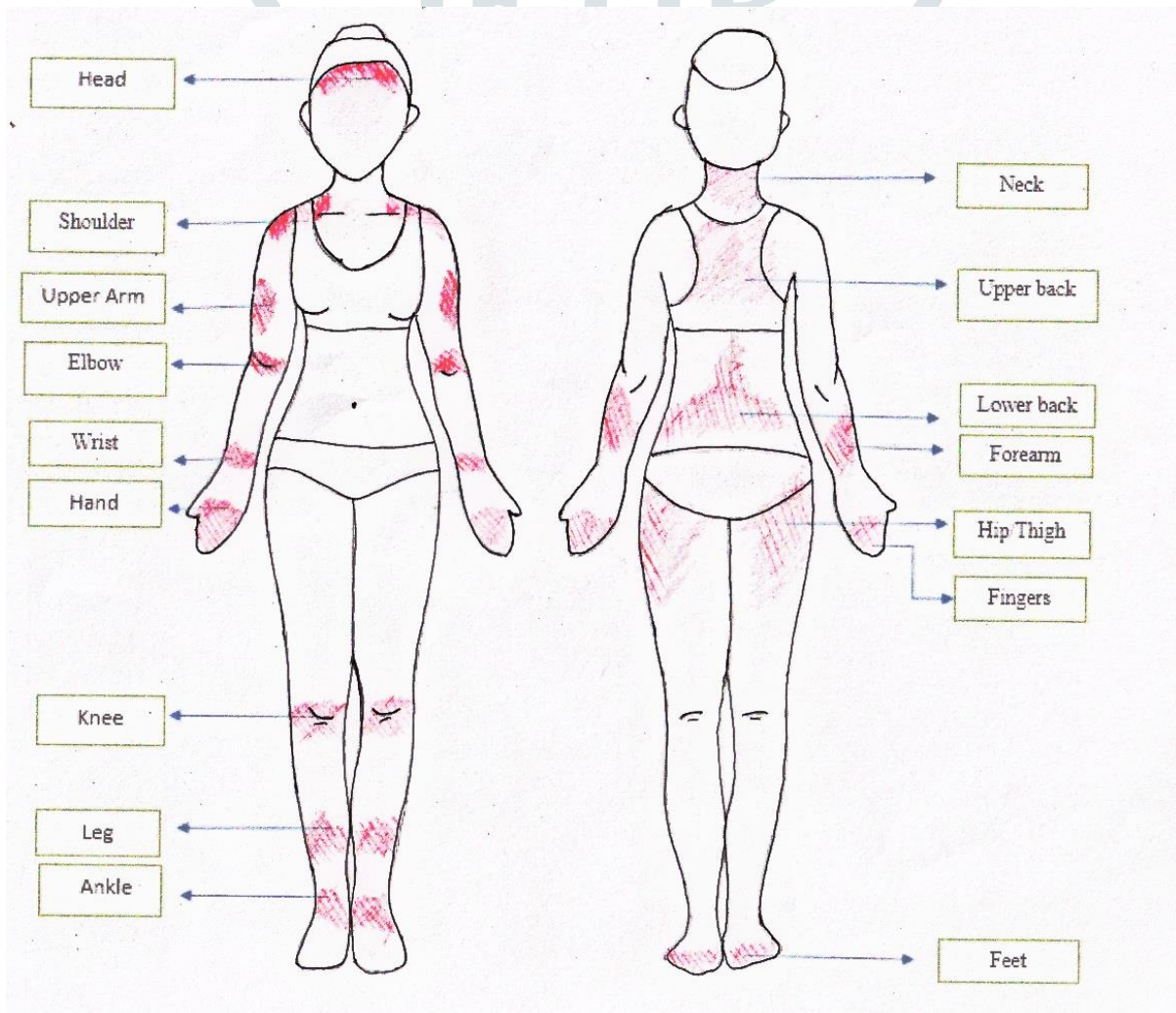


Figure 2 : Different postural problem (Female)

Table 1: A brief of the study done on tea pluckers in relation to MSDs and their ergonomic intervention.

References	Objective of the study	Methods	Musculoskeletal problems faced by Tea pluckers	Ergonomics interventions
Chattopadhyay et al, 2006	The objective of this study was to look at the interrelationships between posture and performance in a plucking-based job in a tea garden.	Total 16 female workers were randomly selected. Body part discomfort (BPD) questionnaire was used and verbal expressions method to assess discomfort or pain in each of 16 body parts. BPD frequency (BPDF) and BPD severity (BPDS) were also measured.	The mid-lower back area caused the most suffering for all groups of employees, followed by the left and right shoulder, neck, upper back, right and left hand, and right and left lower arm.	The results imply that an overall postural shift may be a reliable indication of subjective musculoskeletal discomfort. It suggested that in a tea leaf plucking activity requiring a confined position.
Mittal et al, 2008.	The aim of this study was to gather, evaluate, and correlate data on tea plantation employees' health and safety.	A total of 46 men and 72 women have interviewed in this study. A questionnaire was used to gather information on ergonomic hazards and injuries that have happened while working in tea gardens.	Back pain was the most common pain, followed by neck pain, shoulder pain, leg pain, arm pain, and finger pain.	
Bhattacharyya et al, 2012.	The objective of this study was to evaluate the role of ergonomics to improve work condition of tea garden workers.	In this study, 180 women workers as samples in the age group of 35-50 yrs. Ergonomic risk factor analysed by OCRA and QEC. Occupational stress-WMSDs and MSDs NMQ (Nordic Musculoskeletal Questionnaire) and the body map were used to gather data on cumulative trauma disorders (MSDs).	Workers reported maximum pain in the head and upper back, which was followed by neck, buttocks, lower back, etc, but while using an improved basket, there was a significant reduction in musculoskeletal problems relating to the head, neck, and upper back.	To reduce the health-related problem of the workers and increase productivity, working conditions (work method and technologies they used in the workplace) need to change. Activity should be carried out with break and most importantly, priority should be given to the ergonomic aspect of work, workers and workplace in tea industries. Ergonomically designed basket can reduce MSD.
Bhattacharyya et al, 2012	The objective of the study was the need to empower women technically so that they may work safely and efficiently. Ergonomically designed Work equipment may enhance work performance efficiency and minimize work-related stress, both of which are beneficial to	Total 90 women workers participated from tea garden. Work related Musculoskeletal disorder were quantified using QEC, RULA. NMQ was used to gather data on prevalence of cumulative trauma disorders (CTDs)	QEC scores were significantly higher for neck, which is followed by back, shoulder and wrist/hand. RULA score was found 7, with very high risk	Tea leaf plucking was discovered to be a time-consuming, laborious process. The posture scores discovered were quite high. WRMSDs were common among the employees. The potential for ergonomic design intervention to boost productivity and workplace health has been observed.

	the production situation.	among the workers		
Dihingia et al, 2012	The objective of the study was to investigate musculoskeletal symptoms among tea pluckers by using standardized Nordic questionnaire.	Total 500 tea pluckers recruited for the study, 463 were females and 37 were males. MSD in workplace was investigated by using A standardized Nordic questionnaire.	Workers reported maximum pain in shoulders followed by the neck, upper back, wrists/hands, lower back, elbows, knees, hips/thighs/buttocks and ankles/feet.	The tea leaf pluckers' musculoskeletal complaints may be minimised by using intervention measures such as reduced load carrying, improved work organisation with task rotations, and enough rest during work.
Vasanth et al, 2015	The objective of the study was to determine the prevalence, patterns, and factors associated with work related musculoskeletal disorder among tea plucker.	Data has been collected by interview method in a standard questioner e.g., Standard Nordic Scale, numeric and facial pain rating tool, and a tool to assess factors associated with WRMDs.	The study reveals that Neck pain among the workers is highly prevalent which is followed by Shoulder, Elbow, Wrist, Upper back, Lower back, Hip, Knee, Ankle.	WRMDs were linked to being older and working for longer periods of time. MSD can be reduced by taking pauses between jobs and minimizing the weight of tea leaves carried by women. Physiotherapy and fitness sessions can be arranged at the estate hospital and clinics. Workers' symptoms and overall health may improve as a result of brief warm-up activities before commencing work.
Gharacheh et al, 2016	The aim of this study was to identify dangerous postures in tea plucking operations in order to minimize the intensities of this job.	Data was collected by filming 30 tea garden employees at the tea garden and processed using CATIA software and musculoskeletal risks are assessed by OWAS, REBA, and RULA.	The study showed that the highest discomfort was in the trunk region, which is followed by the neck and upper arm, lower arm and wrist. OWAS and RULA score shows that maximum workers' working posture is at high risk.	Improvising better postures in the workplace isn't valid unless workers have reasonable access to their jobs. The similarities between the findings of the OWAS and RULA techniques, as well as the differences between the results of the REBA method, may lead to the conclusion that the REBA method should not be used for occupations that are comparable to tea plucking.
Masri et al, 2017	The main aim of this study was to find out the musculoskeletal problems among tea pluckers in Malaysia.	This survey was done on 236 workers where 201 workers were male and 33 were female. Data were collected by using the Modified Nordic Questionnaire.	Maximum pain was in the wrist, which is followed by lower back, neck, knee, upper back, shoulder, hip and feet, elbow, and ankle.	Tea pluckers' WMSD symptoms and pain may be reduced by using ergonomic treatments such as load carriage reduction, improved work organization with task rotations, and adequate rest during work.

Tassanawong et al, 2018	The objective of this study was to investigate the prevalence of musculoskeletal disorders and the relationship between ergonomic factors and musculoskeletal disorders.	This study was a cross-sectional descriptive study. A total of 167 workers participated in the study, 55.1% were males and 44.9% were females. The data were collected by using a questionnaire about exposure to ergonomic factors and musculoskeletal disorders with a modified Standardized Nordic Questionnaire.	The study reveals maximum pain in the lower back, which is followed by shoulders, neck, wrist, elbow, hip/thigh, upper back, knee, ankle/ foot.	According to the findings, major variables associated to work-related musculoskeletal problems were an issue among farmers who collected tea leaves. In order to enhance the working process and posture and to reduce MSDs, improper posture factors and repetitive working position for more than 2 hours each day should be considered.
Gayathri et al, 2019	The major goals of this study were to learn about the socio-demographic profile of tea plantation employees, identify their health problems, determine their degree of satisfaction in this profession, and provide suitable recommendations for their betterment.	This study was descriptive in nature. A total of 50 workers, both male and female were randomly selected and a standard questionnaire was used to analyze the prevalence of health issues.	A total of 36.0 % of workers was often suffered from back pain due to standing for a long time regularly and about 38.0 % of workers felt Neck Pain/Shoulder pain by working in a repetitive way like bending their neck or shoulder for a long time when plucking the leaves and carrying the tea leaf bags.	Tea plantation employees have a low level of health knowledge. So, the government and tea management authority should tackle this vital problem to improve their well-being.
Dihingia et al, 2020	The objective of this study was Ergonomic evaluation of work and workload of female worker in tea garden	A total of fifteen female workers were chosen as test participants. The impact of working position was assessed using strategies such as overall discomfort rate and body part discomfort rate. At the end of the day's work, the participants were asked to rate their exertion/discomfort on a 5-point Rating on Perceived Exertion (RPE) scale.	Neck had the highest work-related body part discomfort score on a 5-point RPE scale during tea leaf plucking, followed by upper back, wrist, lower back, upper arm, shoulder, forearm, elbow, knee, and so on.	Tea leaf plucking causes discomfort due to repetitive hand movement in bending posture during plucking while carrying the load of the basket with plucked tea leaves on the back. Women's job stress can be decreased by introducing ergonomic measures such as reduction of a load of plucked tea leaves being carried in the basket and providing adequate breaks during the workday
Marak et al, 2020	The goal of this study was to avoid work-related musculoskeletal disorders (WMSDs) and to examine the musculoskeletal disorders caused by adopting different postures during tea plucking of the Garo women workers.	A survey on 40 workers was done. To evaluate the stress on muscles employed at work, pain as a musculoskeletal disease was measured using a 5-point scale ranging from very mild pain (1) to very severe discomfort (5). A rapid upper limb assessment (RULA) approach was	Workers reported maximum pain in the head which was followed by neck, both fingers, lower back, upper back, and feet.	Rest times during work, ergonomic assistance, and personal protection equipment are all required to reduce the pain of female tea pluckers.

		used to measure pain in the upper extremity. A rapid entire body assessment (REBA) approach was used to measure pain across the entire body.		
Chandrasekara et al, 2020	The goal of the study was to determine the prevalence of musculoskeletal pain and environmental health risks among Sri Lankan tea pickers.	In this study, a total of 378 tea pluckers were recruited using a simple random selection procedure for descriptive cross-sectional research. A validated, pretested interviewer-administered questionnaire was used to collect data.	Maximum pain was in the Lower back, which is followed by knee, upper back, shoulder pain, hand/arm, neck, and ankle.	Tea pluckers had a high rate of musculoskeletal pain, with the lower back region being the most prevalent source of discomfort. Musculoskeletal discomfort was linked to stress, duration of work, and age. To reduce musculoskeletal discomfort among tea pluckers, steps should be done to reduce the risk factors linked with occupational health concerns.
Chakraborty et al, 2021	The Objective of this study was to find out the prevalence and pattern of musculoskeletal illnesses among tea garden employees, as well as what variables contribute to illness.	This study included 210 female tea garden employees in a cross-sectional study. The Standard Nordic Musculoskeletal Questionnaire was used to collect data on musculoskeletal morbidities, and the Rapid Entire Body Assessment (REBA) worksheet was used to assess ergonomic risk.	Workers reported maximum pain in Elbow which was followed by Wrist, Shoulder, Lower back, Knee, Neck, Upper back, Hip, Ankle.	Female tea garden workers in Darjeeling were found to have a significant rate of musculoskeletal morbidity. Ergonomic mechanised aid in tea plucking can lower this proportion of MSD, which might help to reduce illness absenteeism and boost productivity.

Summary

Based on the information presented above, it can be concluded that the female workers are primary in tea plucking and tea pluckers who work in a tea garden experience discomfort in many regions of their bodies, a condition known as work-related musculoskeletal disorders. This condition can reduce their working age. These MSDs are caused by poor working posture, carrying a heavyweight on the back or head, and doing repetitive tasks in the same position for long periods of time with few or no breaks. The literature review outlines several ergonomic interventions, such as using various methods e.g., REBA, RULA, OWAS, SNQ, OCRA, etc. to identify MSDs and multiple ideas to alleviate discomforts, such as ergonomic basket design, skill training, and active worker engagement in MSD recognition. Anthropometric measurement and nutritional status of tea garden workers can be useful for the early detection of MSD. As a result, by incorporating ergonomics into the tea plucking process, difficulties and musculoskeletal injuries may be reduced to a larger level.

Scope for further research

There is need for more investigation into the issues faced by female tea pluckers and developing new ergonomically designed baskets.

Suggestions

There is a pressing need to incorporate ergonomics into the tea industry to improve health qualities as well as working capabilities of female tea pluckers.

Government agencies and non-governmental organisations (NGOs) can provide ergonomics training and orientation to female tea workers.

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