

Prevalence of musculoskeletal disorders and their association with ergonomic physical risk factors among women working in tea gardens of Darjeeling district of West Bengal, India

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ABSTRACT

Introduction: Work related musculoskeletal disorders (WRMSDs) is common among tea-plucking folks and may be attributed to the long duration of work in same posture, the load they carry while plucking and transporting the leaves to the nearest depot, improper job rotations and the difficult hilly terrains. The objective of this study was to determine the prevalence and pattern of musculoskeletal disorders among tea garden workers and to ascertain the risk factors for the same.

Methods: A cross-sectional study was conducted among 210 female tea garden workers employed in tea gardens of Darjeeling district using 30 cluster sampling design. Data on musculoskeletal morbidities were collected using Standard Nordic Musculoskeletal Questionnaire and ergonomic risk was assessed by Rapid Entire Body Assessment (REBA) worksheet. Study duration was from March 2017 to February 2018.

Results: Proportion of musculoskeletal disorders in past 12 months was 92.4% and in past seven days was 71.4%. Upper extremities were the most commonly affected body part. Higher altitude, age, BMI, more duration in present job, history of work-related injuries and increased REBA risk assessment score were found to be significantly associated with musculoskeletal disorders.

Conclusion: Musculoskeletal morbidities among female tea garden workers of Darjeeling were found to be considerably high. Ergonomic mechanised assistance in tea plucking can reduce this proportion of MSD and thus may go a long way in reducing sickness absenteeism and increasing productivity.

Key words: Female, REBA employee assessment worksheet, Standard Nordic Musculoskeletal Questionnaire, Tea garden workers, Work related musculoskeletal disorders.

Introduction

In all aspects of tea production, consumption and export, India has emerged to be the world leader, mainly because it accounts for 31% of global production.¹ Since the establishment of the first tea

garden by the British East India Company in 1835,² India has become the world's largest consumer of black tea with the domestic market consuming 911 million kg of tea during 2013-14, thereby, tea has almost become the staple beverage of every Indian household. India is ranked second in terms of production and fourth in terms of tea exports, and thereby tea industry contributes to 0.26% of India's GDP.³ India's tea plantations are largely grouped into two regions—North East India and South India.³ Darjeeling is famous globally for some of the best flavours of tea.

Work Related Musculoskeletal Disorder (WRMSDs) are seldom life threatening but they impair the quality of life

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of a large proportion of the adult population. It develops over time and may affect muscles, joints and tendons in all parts of the body. They can be episodic or chronic in nature and can also result from injury sustained in a work-related accident. They can progress from mild to severe disorders.⁴

Work-related disorders can develop in an occupational setting due to the physical tasks with which individuals carry out their normal work activities. WRMSDs are associated with work patterns that include fixed or constrained body positions, continual repetition of movements, force concentrated on small parts of the body, such as the hand or wrist and a pace of work that does not allow sufficient recovery between movements. Additionally, workplace psychosocial factors such as organisational culture, health and safety climate and human factors may create the conditions for WRMSDs to occur. Generally, none of these factors acts separately to cause WRMSDs. They more commonly occur as a result of a combination and interaction among them.⁵

The work of tea plucking is still being practised in a traditional manner without considering its adverse health effects. Long duration of work in same posture, the load they carry while plucking and transporting the leaves to the nearest depot, improper job rotations and the difficult hilly terrains may attribute to work related musculoskeletal disorders in the tea garden population. The tea plucking is traditionally a women centric activity with the men being employed for other activities but not tea plucking. There is dearth of published literature about WRMSDs among the tea garden workers working in the difficult terrains of Darjeeling where the chief economy rests on tea industry. Thereby, this study explores the pattern and prevalence of WRMSDs among the workers and also find out interplay of risk factors causing them.

The objectives of this study were to determine the proportion and pattern of musculoskeletal disorders and to ascertain the various risk factors associated with work related musculoskeletal disorders among women tea garden workers.

Methods

It was a descriptive cross-sectional study conducted in Darjeeling district of West Bengal. This district has 4 subdivisions - Darjeeling, Mirik, Kurseong and Siliguri and 9 Community Development Blocks. There are 137

notified tea gardens in Darjeeling district distributed among the four sub-divisions. Study duration was from March 2017 to February 2018. Women between 20-60 years of age working in tea gardens in the study area for at least 1 year were included in the study.

Sample size was estimated using single proportion formula for cross sectional studies considering the factors of: desired level of confidence, acceptable margin of error, relative precision (as finite population taken), design effect of the sampling technique, anticipated proportion of musculoskeletal disorders.⁶ Community based studies in North Indian context showing proportion of musculoskeletal disorders among tea garden workers are lacking. So a study conducted in Tamil Nadu among tea garden workers in 2016 was considered here, where 78.5% of tea garden workers had experienced musculoskeletal pain in past seven days.⁷ The anticipated proportion of musculoskeletal disorders among the study population thus will be taken as 78.5%. Considering 95% level of confidence and 10% relative precision, the sample size will be calculated using the following formula:

$n = Z^2 (1 - \alpha/2) P (1 - P) / e^2$ where:

- $Z (1 - \alpha/2) = 1.96$ (at 95% confidence interval)
- $P =$ anticipated proportion of musculoskeletal disorders among tea garden workers (78.5%)
- $e =$ relative precision (10% of 78.5)

Thus, the calculated sample size comes to be $n = (1.96)^2 \times 0.785 \times 0.215 / (0.10 \times 0.785)^2 = 105$

As cluster sampling was done, a design effect of 2 was considered. Thus sample size came out to be 210.

Cluster sampling technique was applied to select the study subjects. Each tea garden of Darjeeling district was considered as 'cluster'. In the first stage list of all tea gardens of Darjeeling district was prepared with their respective population and cumulative population and 30 clusters (tea gardens) were identified using cluster sampling technique. In the second stage, from each selected cluster equal number of study subjects was included, thus cluster size will be $210/30 \sim 7$

In an identified cluster which is a tea garden, list of all the women working as tea pluckers was prepared with the help of garden authorities. Seven women were selected by simple random sampling (without replacement) from the prepared sampling frame from each cluster. Their addresses were obtained beforehand from local health workers and they were

interviewed at their household at mutually convenient time. If there are non-responders from the selected seven women in each cluster, rest of the women were selected again randomly from the previously prepared sampling frame in each village to complete the cluster size of seven.

Pre-designed pre-tested interview schedule consisting of background characteristics & socio-demographic characteristics with Standard Nordic Musculoskeletal Questionnaire, Wong-Baker Pain assessment Tool, REBA employee assessment worksheet, and any relevant medical records/prescription was done. The instrument used in this study is the Standard Nordic Questionnaire (SNQ) which records musculoskeletal symptoms and screens for musculoskeletal disorders in an ergonomic context.⁹ SNQ is a valuable tool in occupational health care service research as screening for musculoskeletal symptoms in occupational settings.¹⁰ REBA employee assessment worksheet is an ergonomic assessment tool which uses a systematic process to evaluate whole body postural MSD and risks associated with job tasks and was used in this study.¹⁰

The eligible women tea garden workers were interviewed using the pre-designed pretested schedule after obtaining informed written consent. The schedule was customised for the study with the help of the subject experts of the Department of Community Medicine of North Bengal Medical College. Musculoskeletal disorders are a diverse group of disorders regarding pathophysiology and as per World Health Organization (WHO), the burden of Musculoskeletal Disorders can be assessed in terms of problems associated with them which include pain, ache, discomfort, numbness or disability or in relation to the cause such as joint disease or trauma.

Data was collected by the researchers after translation, back-translation, and re-translation of the Standard Nordic Musculoskeletal Questionnaire, Wong-Baker Pain assessment Tool, REBA employee assessment worksheet with the help of language experts, followed by pre-testing among a convenience sample of 30 individuals attending the OPD of Kiran Chandra Tea Estate, Naxalbari, the rural field practice area of the Department of Community Medicine of North Bengal Medical College and Hospital.

Data were collected in predesigned and pretested schedule and handled with strict confidentiality.

Data were entered into Excel (Microsoft Inc.) and all calculations were done using IBM Statistical Package for the Social Sciences (SPSS) (Version 20.0, IBM). Data were analysed and presented using principles of descriptive and analytical statistics. Univariate logistic regression and multivariate logistic regression was carried out with the variables.

The study was conducted after the approval of the Institutional Ethics Committee of North Bengal Medical College, Darjeeling. Informed consent was obtained from all the study participants. Permission for the study was sought from the Tea board of India from its office in Kolkata and the Chief medical officer of health of Darjeeling district.

Results:

Women belonged to age group of more than 40 years of age were 97.5%. Among all the participants 96.4% were working at an altitude of more than 500m and 95% of workers belonged to BPL families were having musculoskeletal disorders. (Table 1)

Among overweight workers, 95.6% and of underweight, 95% workers had musculoskeletal disorders. Women having musculoskeletal disorders had pallor comprised 97.3%. (Table 2)

Duration in present job, average working hours per day, last working day harvest, number of episodes of work-related injury in past 1 year and REBA score were found to be significant factors influencing the musculoskeletal disorders among women working in tea gardens of Darjeeling. (Table 3)

Prevalence of musculoskeletal disorders in past 12 months was 92.4% and in past 7 days was 71.4%. Upper extremities were the most commonly affected body part. Elbow pain was the commonest in both past seven days (55.7%) and past 12 months (82.4%). Elbow pain and low back pain seems to be more chronic in both past 7 days and past 12 months duration periods. (Table 4)

Those working at an altitude of 500 meters or less and aged less than 40 years were less likely of developing musculoskeletal disorders. Musculoskeletal disorders in women below poverty line (BPL) families is more likely, however; it was not found significant on univariate regression analysis.

There was more likelihood of musculoskeletal disorders among women who were underweight, overweight or had pallor. But only being overweight was statistically significant predictor of musculoskeletal disorders on univariate logistic regression analysis.

Duration in present job, average working hours per day, last working day harvest, number of episodes of work-related injury in past 1 year and REBA score were found to be significant factors influencing the

musculoskeletal disorders among women working in tea gardens of Darjeeling.

Tables 5, 6 and Figure 1 show three predictive models for predicting the musculoskeletal disorders among the women working in the tea gardens that were developed for the present study. Model 1 includes only the socioeconomic variables; Model 2 includes the socioeconomic and physical parameters related variable and Model 3 includes the ergonomic related variables in addition to the variables in Model 2.

Table 1: Socio-demographic risk factors of musculoskeletal diseases among study subjects (N=210)

Socio-demographic risk factors	Total N	Musculoskeletal disorder		COR (95% CI)	AOR (95% CI)
		Absent N (%)	Present N (%)		
Age					
< 40 years	92	13 (14.1)	79 (85.9)	*0.159 (0.044-0.575)	
>= 40 years	118	3 (2.5)	115 (97.5)	1.00 (Reference)	1.00 (Reference)
Altitude					
< 500 m	56	10 (17.9)	46 (82.1)	*0.186 (0.064-0.541)	
>= 500 m	154	6 (3.9)	148 (96.1)	1.00 (Reference)	1.00 (Reference)
Socio-economic status					
Below poverty line	100	5 (5)	95 (95)	2.111 (0.707-6.304)	
Above poverty line	110	11 (10)	99 (90)	1.00 (Reference)	1.00 (Reference)

Table 2: Physical risk factors of musculoskeletal diseases among study subjects (N=210)

Physical risk factors	Total N	Musculoskeletal disease absent	Musculoskeletal disease present	COR (95% CI)	AOR (95% CI)
		N (%)	N (%)		
BMI					
Underweight	60	3 (5)	57 (95)	3.420 (0.877-13.334)	
Normal	59	9 (15.3)	50 (84.7)	1.00 (Reference)	1.00 (Reference)
Overweight	91	4 (4.4)	87 (95.6)	*3.195 (1.147-13.368)	
Pallor					
Negative	60	12 (20)	48 (80)	1.00 (Reference)	1.00 (Reference)
Positive	150	4 (2.7)	146 (97.3)	1.396 (0.500-3.900)	

Table 3: Ergonomic risk factors of musculoskeletal diseases among study subjects (N=210)

Ergonomic risk factors	Musculoskeletal disorder				COR (95% CI)	AOR (95% CI)
	Absent		Present			
	Mean	SD	Mean	SD		
Duration in present job	5.19	4.34	21.62	12.23	*1.257(1.110-1.423)	*3.901(2.236-8.425)
Average working hours per day	9.63	0.81	8.71	0.91	0.320(0.161-0.635)	1.457(0.414-5.125)
Last working day harvest	59.37	15.31	34.16	9.87	*0.893(0.857-0.930)	*0.068(0.014-0.325)
Number of episodes of work related injury in past 1 year	1.31	1.30	5.01	3.27	*2.291(1.530-3.431)	*3.279(1.367-8.768)
REBA score	3.69	1.35	6.36	2.62	*2.040(1.284-3.242)	*7.263(1.214-13.456)
Total	16(7.6%)		194(92.4%)			

Table 4: Pattern of musculoskeletal pain in past 7 days and past 12 months among the study subjects (N=210)

Type of joint pain	Pattern in last 7 days	Pattern in last 12 months
	N (%)	N (%)
Neck pain	31 (14.8)	78 (37.1)
Shoulder pain	49 (23.3)	128 (61.0)
Elbow pain	117 (55.7)	173 (82.4)
Wrist pain	88 (41.9)	163 (77.6)
Upper back pain	23 (11.0)	23 (11.0)
Lower back pain	107 (51.0)	117 (55.7)
Knee pain	71 (33.8)	97 (46.2)
Hip pain	0 (0)	10 (4.8)
Ankle pain	1 (0.5)	5 (2.4)

* Multiple responses present

Table 5: Multivariate models of predictors of musculoskeletal disorders among study subjects

Variables		Model 1	Model 2	Model 3
Intercept		-1.867	-5.371	-1.638
Socio-demographic variables	Age	*1.151(1.088-1.217)	*1.172(1.096-1.253)	1.036(0.907-1.184)
	Socio-economic status			
	BPL	0.793(0.201-3.133)	1.119(0.251-5.000)	0.606(0.032-11.327)
	APL	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
	Altitude			
	< 500 m	*0.116(0.029-0.468)	*0.107(0.023-0.509)	0.595(.029-12.016)
>= 500 m	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)	
Physical variables	BMI			
	Normal		1.00 (Reference)	1.00 (Reference)
	Underweight		1.007(0.181-5.590)	3.404(0.220-52.584)
	Overweight		7.075(0.825-60.670)	23.216(0.816-660.192)
	Pallor			
	Absent		1.00 (Reference)	1.00 (Reference)
Present		1.025(0.241-4.361)	2.867(0.280-29.391)	
Ergonomic variables	Duration in present job			1.230(0.940-1.610)
	Average working hours per day			0.871(0.164-4.636)
	Last working day harvest			*0.923(0.857-0.994)
	Number of episodes of work-related injury in past 1 year			1.658(0.835-3.295)
	REBA score			1.895(0.887-4.047)

Table 6: Model statistics for the three predictive models

	Omnibus Tests of Model Coefficient			Hosmer Lemeshow	-2 Log Likelihood	Cox & Snell R Square	Nagelkarke pseudo R square
	Chi-square	df	P value				
Model 1	44.747	3	0.000	0.975	68.387	0.192	0.461
Model 2	50.698	6	0.000	0.852	62.435	0.214	0.515
Model 3	82.344	11	0.000	0.714	30.789	0.324	0.779

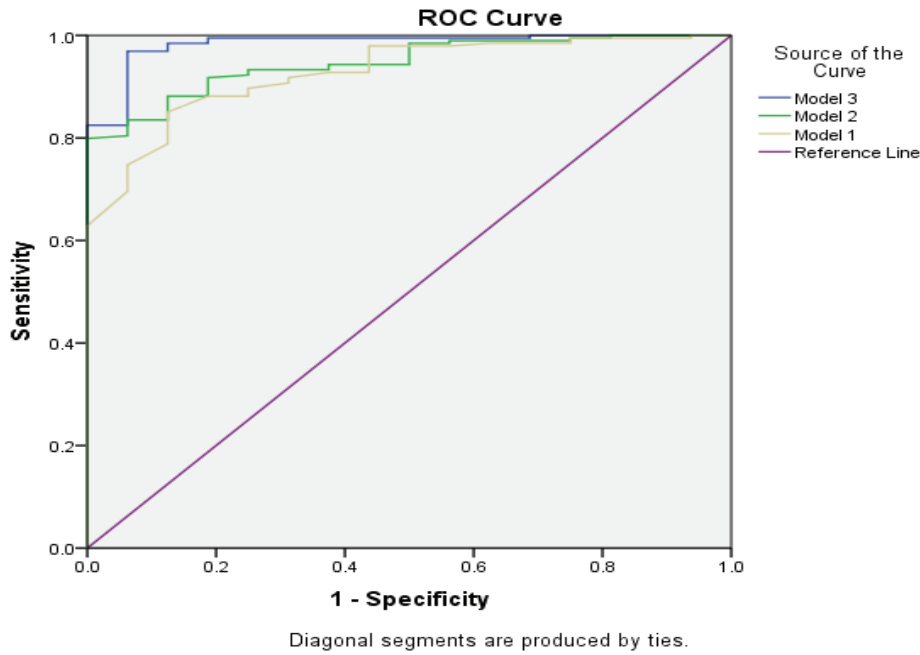


Figure 1: ROC curve showing the three predictive models

Area under the curve	
Test Result Variable	Area
Model 1	0.927
Model 2	0.946
Model 3	0.984

Discussion

The women work in hilly undulating terrains of tea gardens of Darjeeling. The work includes plucking tea, carrying the load on their back up to the unloading point, waiting for their turn for unloading. On an average each woman collects about 23-28 kg of tea leaves depending upon the season of the year.

There are several studies conducted among different occupational groups regarding WRMSDs. The prevalence of lower back pain in commercial vehicle drivers in Malaysia,¹³ professional bus drivers in Israel,¹⁴ farmers in Ireland,¹⁵ secondary school teachers in Saudi Arabia¹⁶ and video display terminal users in Kolkata¹⁷ was 60.4%, 45.4%, 56%, 79.17% and 90.78% respectively. Thus, it can be inferred that the WRMDs is a common phenomenon but the pattern of it depends on the occupation. It was seen in a systematic review by Osborn et al. that the prevalence of MSD was more in farmers than in non-farmers and lower back pain was the most common region followed by the upper and lower extremities.¹⁸

The prevalence of WRMDs for the past 12 months was 92.4% in our study as compared with 11.52% in Dibrugarh, 7.08% in Delhi and 9.53% in Jodhpur in the general population as obtained from a multi-centric study by ICMR about epidemiology of musculoskeletal disorders in India.¹¹ In a study done at tea garden of Tamil Nadu and palm oil plantation in Malaysia the prevalence of MSD in past 12 months were 83.6% and 93 % respectively.^{7,12} Thereby, this increased prevalence can be attributed to the pattern and conditions of work done by the plantation workers as compared to the general population.

In our study, upper extremities were the most affected body part. Elbow pain was commonest in both past 7 days (55.7%) and past 12 months (82.4%). Elbow pain and low back pain seems to be more chronic with high prevalence in both past 7 days and past 12 months duration periods. While in a study in a single tea garden in Tamil Nadu, the past 12 months and 7 days prevalence of pain was highest in the shoulder and lower back, respectively.⁷ Another study among workers of a palm plantation, the highest prevalence was of low

back pain.¹² The heavy loads carried by tea plantation women and standing for long hours with the weight in undulating difficult terrains of tea gardens of Darjeeling affects their spines leading to chronicity of low back pain. The repeated hand movements of plucking the tea with poor job rotations and less intervening rest periods leads to increased strain on elbow, wrist and shoulder joints leading to their increased WRMSDs in these regions.

The socio-demographic risk factors identified to be attributing to WRMSD are increased age, working in high altitude and poor socio-economic status. In this study, most of the women pluckers aged above 40 years were from BPL families. It signifies lack of periodic health check-ups and social security, as a person with chronic pain must attend her regular work to meet the family expenses. High altitude and rough terrains are part of tea garden cultivation and the women pluckers working with loads over their spine in a difficult posture (as seen in the REBA worksheet) assimilates further assault to the musculoskeletal system resulting in a chronic pain. Tea-plucking women workers adopt static as well as dynamic posture for a long duration (8-10hours/day) reduces blood flow, further deplete nutrients, and lead to a build-up of metabolic waste in their back. Thus, the spinal load is increased which may be another cause of their reduced back strength. Raised BMI is the physical factor identified for WRMSDs among tea garden workers. Overweight, although found in a small percentage of workers further increases the load on the spine culminating in low back pain while under-weight women are more prone for symptoms associated with fibromyalgia. Pallor when coupled with all those factors further causes poor nutrients and poor oxygen delivery to muscles involved in maintaining posture and performing work thus aggravating their symptoms.¹⁹ The positive association between prevalence and age, poor socio-economic, altitude and nutritional status means that musculoskeletal disorders are likely to be an increasing public health challenge in the future.

The duration in present job, average working hours per day, last working day harvest, number of episodes of work-related injury in past 1 year and REBA score were the ergonomic risk factors associated with WRMSDs. The findings of our study imply that that the respondents were working in a poor posture and there could be a risk of injury as well as deterioration of their muscle & bone health from work posture. The reasons for this need to be investigated further by occupational therapist and

locally feasible changes should be brought about soon to prevent further injury & restore health & well-being of the tea workforce of India. A study on Dutch agricultural workers had similar findings with respect to age, BMI and increased workload.²⁰

Regarding the results from the REBA analysis, our study showed that the work of tea plucking and carrying the loads were accomplished with bad postures like another study done on Garo women working in tea gardens of Meghalaya, India and also in workers of other industries like dairy farming in Iran.^{21,22}

Limitations

The responses may be subjective or guarded which is considered as a limitation. Workers with recent episodes of MSD will remember the events much better and hence can affect the response to the questionnaire, paving way for recall bias.

Conclusion

The study revealed that age, nutrition, altitude coupled with ergonomic risk factors were found to be important predictors of work-related musculoskeletal disorders. Thus, the modifiable risk factors that is ergonomic factors needs to be intervened at the earliest because it has two distinct implications, it hampers the quality of life of the workers by increasing their plight of pain on the one hand and on the other hand it may increase sickness absenteeism and leads to diminished productivity in tea plantation industry.

Provision of regular health check-ups, revision of wages system which in most cases is based on weight-rate system, ergonomic mechanised assistance in tea plucking, periodic evacuation of the harvest loads and reducing the distance between the plucking area and the evacuation complex can reduce this proportion of musculoskeletal disorders. Tea gardens has an array of job from working in tea factories, working in garden, working in manure sections, pesticides section to office job. If proper job rotation can be done for the workers with provisions of plucking job for a few hours each day followed by other less strenuous job in latter part, that may help dissipate the toxic metabolites from the spinal muscles that accumulates from the drudgery. Locally available & feasible technologies such as adjustable strap to support the head for the tea-plucking basket while carrying the load in the hilly terrain along with some personnel protective equipment for fingers like rubber finger cots and finger stalls should be

introduced. As per Plantation Labour Act, India, 1951, the periods of work of adult workers each day shall be so fixed that no period shall exceed fifty-four hours per week with provisions of a weekly holiday and for adolescents it is fixed at forty-eight hours per week.²³ These modifications if followed may go a long way in reducing sickness absenteeism and increasing productivity.

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