

Original Research Article

Understanding musculoskeletal symptoms in small-scale dairy employment: insights from a cross-sectional epidemiological study in Bhubaneswar, Odisha

Snigdha Singh^{1*}, Sonali Kar¹, Avinash Naik²

¹Department of Community Medicine, Kalinga Institute of Medical Sciences, KIIT University, Bhubaneswar, Odisha, India

²Department of Orthopedics, Kalinga Institute of Medical Sciences, Bhubaneswar, Odisha, India

Received: 21 July 2026

Accepted: 23 October 2026

*Correspondence:

Dr. Snigdha Singh,

E-mail: drsnigdhas92@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The increased demand of dairy products in the urban areas is encouraging an increase in uptake of dairy as an occupation. Thus, this ownership generates a silent demand for task specialization, work efficiency and working hours. This study was done with the objective of bringing out the nexus between dairy work and different musculoskeletal symptoms reported in these dairy workers.

Methods: A cross-sectional study conducted from September 2018 to August 2020, among 360 small-scale dairy workers of Bhubaneswar in whom work-related musculoskeletal symptoms and its association with type of work done at dairy farm were assessed, using a pretested semi-structured, mixed questionnaire along with a hand symptom questionnaire.

Results: 96.7% workers reported MSS in any anatomical site while 88.4% reported MSS in ≥ 2 sites. There was strong association between type of work at dairy farm and MSS among dairy workers (aOR 3.44; 95%CI: 1.03-5.86; $p=0.045$).

Conclusions: Musculoskeletal symptoms are prevalent among dairy workers due to repetitive tasks, heavy lifting, inappropriate postures, and prolonged time of standing and is more prevalent among those doing parlor work.

Keywords: Dairy worker, Musculoskeletal symptom, Occupational health, Carpal tunnel syndrome, Ergonomics, Musculoskeletal disorders

INTRODUCTION

Dairy workers are the ones who take care of the cattle herd and perform milking.¹ In India, and particularly in Odisha, dairy farming is largely characterized by small-scale, unorganized units where manual labor predominates. With the rising demand for milk, dairy farms operate throughout the week, often with milking frequencies exceedingly twice daily, thereby increasing cumulative physical workload.^{2,3} This intensified work demand has potentially hiked the risk of work-related

musculoskeletal symptoms (MSS) among them.^{3,4} In Odisha, the small-scale workers perform traditional hand milking that affects fingers, wrist, elbow, shoulder, muscles of upper extremities, back, etc. due to significant involvement of forceful exertions, repetitive hand and wrist movement and awkward wrist motion.³⁻⁶ Carpal tunnel syndrome (CTS) has been reported as one of the most common manifestations of such occupational strain.^{4,7} Manual handling of heavy milk cans, fodder, and milk transportation often on foot or bicycle, adds to fatigue and increases likelihood of MSS.³ These lead to

limiting injuries, restricted workdays, loss of work time for the workers bringing a drop in their income.^{4,8} To safeguard their earning, dairy workers inspite of being unhealthy, work, handle the cattle and milk which may be apprehended as a factor for irreversible illness in the workers and milk contamination, respectively.⁹

Most studies on ergonomic risk assessment in dairy farming have focused on milking practices while non-milking tasks like manure disposal, shed cleaning, etc. have been less explored. There is evidence of association between type of work at dairy farm and MSS from western countries, findings of which are not applicable for dairy systems in India due to stark difference in milking methods, herd size, facility and farm set-up.^{1-4,8,10} Thus, there remains a dearth of research in the developing countries.

The face of today's global dairy industry is changing. The technological advances in large-scale production have dominated production systems of developed nations, while small-scale dairies have gained prominence in the developing world.¹⁰ To optimize the development of small-scale dairies, the effect of management practices, farmer training, culture, milk safety and the potential risk of MSS are aspects that must be examined. To the best of our literature review, studies have not been conducted in Odisha to evaluate MSS among dairy workers, underscoring the need for context-specific investigation.

Current study was conducted to assess the prevalence of MSS among the unorganized-small-scale dairy workers of urban Bhubaneswar, and to determine the association between type of work at dairy farm and musculoskeletal symptoms among dairy workers since, the well-being of workers is paramount for sustainable and efficient farm operations.

METHODS

By considering 33.3% prevalence of MSS, 95% confidence level, and 5% absolute precision, the calculated sample size was 356 and 360 dairy workers were ultimately enrolled from September, 2018 to August, 2020 in Bhubaneswar, Odisha.³

Study criteria

To be included in the study, the worker had to be a resident of Bhubaneswar (for >5 years), age 18 years and above, irrespective of the gender, engaged in this profession for at least one year and working actively in the dairy farm for at least 2-4 hours every day and consent to participate was must.

Those temporarily involved in dairy, or had history of diagnosed musculoskeletal disorders, or were suffering from acute illness at the time of interview, were not included.

Study procedure

Multistage random sampling was used to identify wards and households with small-scale dairy workers in each of the 3 Zones of Bhubaneswar city. With help from the head of the wards, households with dairy as primary occupation were identified. It was further made sure that of the workers selected from each dairy, one should be actively involved in milking process (Parlor worker) and the other should be mostly doing farm management, including cleaning sheds, disposing manure, transportation of milk cans and handling cattle (non-parlor worker).^{4,10} 360 dairy workers working at 180 small-scale dairies i.e. two workers from each dairy were thus taken up.

Study tool

A semi-structured, mixed (both open and close-ended questions) questionnaire was administered to interview the participants during house visit, by a team led by the researcher.^{1,9} The tool was self-developed using references from similar articles from literature and tested for validity.¹¹⁻¹⁴ It was translated and back translated into the local language Odia, for the ease of eliciting answers from the respondents and their ease in comprehending the questions.

For the study, MSS was defined as a confirmation by the participants for nine anatomic sites (neck, shoulder, upper back, lower back, elbow, wrist/hand, hip/thigh, knee, feet), for any symptoms like pain, discomfort, restricted mobility which is persisting at the time of study and warrants medication or rest. Questionnaire asks if, during the last 12 months, the respondent: had work-related ache, pain, discomfort, which had prevented the respondent from doing the daily work and if the respondent had reported a doctor about the symptom.¹⁰ For every anatomical site, a dichotomous variable was used implying if a worker had experienced MSS or not.² We examined MSS by sites grouped into three regions i.e. neck and upper back; upper extremity-shoulder, elbow and wrist/hand; and lower extremity: hip/thigh, knee and feet) to maximize statistical power.¹⁰ It was further explained to each worker by the researcher that a work-related MSS could be any ache, pain or discomfort that was experienced in any body part during or after completing work shift and aggravated by the work, if left medically unattended.

Additionally, a Hand symptom questionnaire was applied on the participants, used in some previous studies.¹⁵⁻¹⁸ Participants were instructed to rate hand symptoms such as numbness, aching or tingling on a 0–10 scale and shade the appropriate symptoms as per their location on a hand diagram. Hands were classified as having characteristic CTS symptoms: if participants rated their symptom intensity at least 2 on the 0–10 scale, had numbness or tingling localized in ≥ 2 of the first four fingers corresponding to median nerve distribution, and

the symptoms must have occurred sometime in the past 1 year, have been present for at least 2 weeks and has succumbed to while doing respective work in the dairy.

The median distribution consisted of the ventral aspect of the digits 1, 2, 3, ventral-radial aspect of the 4th finger, as well as the dorsal aspect of the distal phalanx of each of these digits. This classification was like that used in other epidemiological studies.^{4,19,20} On those with MSS, Phalen's test was performed and Tinel's sign was elicited by Orthopedician in the team, to provisionally diagnose CTS.^{21,22} Conducting the Nerve Conduction Study (NCS) (confirmatory test for CTS) for the sample was beyond scope, as it was a non-funded study.⁴

The questionnaire was pilot tested in 20 dairy farms before being finalized for the study. As there are no standards and regulatory body for the small-scale dairy workers, to monitor their work and their environment, this study tried to bring it to limelight. The respondents were subjected to health check-up as well as anthropometric assessment and asked for relevant past history.

Statistical analysis

Data analysis was done using STATA 17.0. Data was checked for distribution of covariates and missingness. The preliminary analysis included examination of all the variables and description of the sample. All descriptive data for the demographic and occupational variables were reported as means and standard deviations, or frequencies and percentiles. Cross-tabulation of variables and chi-square test was conducted to examine association of exposure with outcome i.e. MSS in each exposure group. Prevalence of CTS were determined for parlor and non-parlor workers. Multivariate logistic regression with 95% confidence interval and p-value was reported for the association of type of work at farm and MSS among dairy workers.

Ethics consideration

After due clearance from IEC (Ref. No.-KIMS/KIIT/IEC/088/2018) and participant consent, the study was conducted. There is no conflict of interest.

RESULTS

The cross-sectional study among 360 dairy workers reported a mean of 18.15 years of dairy farming experience, with a minimum of 4 years and a maximum of 43 years.

Participants with age <40 years were found to be carrying out parlor activity while those above 40 years, were non-parlor workers (75.0%; $p<0.001$) (Table 1). The mean BMI was comparable between the two groups (22.8 ± 3.5 kg/m² among parlor workers vs. 24.1 ± 2.4 kg/m² among non-parlor workers; $p=0.55$). It was noted that the workers who were comparatively new to the occupation, were mostly into non-parlor work ($p=0.04$). The non-parlor workers were found to invest ≥ 6 hours/day in dairy farms (45.0%; $p=0.05$), diagnosed for co-morbidities like diabetes (24.5%; $p<0.001$) and hypertension (36.6%; $p=0.03$). Engagement in alternate occupations did not differ significantly between groups (13.3% vs. 20.0%; $p=0.78$). All participants in both groups reported right-hand dominance.

Behavioral risk factors such as smoking tobacco (26.6% vs. 20%; $p=0.56$) and chewing tobacco (86.6% vs. 71.7%; $p=0.33$) were more common among parlor workers, although these differences were not statistically significant.

Table 2 represents detailed description of the small-scale dairy farms. All farms (100.0%) reported using manual mode of milking. Milk was reported to be sold out within 1-4 hours after collection and majority (38.3%) used cycle while 33.3% walked to deliver milk. 40.0% farms reported that they transported milk to different BMC Zones, investing large amount of time and effort. 70.0% of the farms report milking cattle twice daily. Majority of the sheds had mud floors (71.7%) and none had gutter to drain excreta of the cattle, leading to visual nuisance and accidents by slipping off over it. 86.6% sheds were cleaned twice daily. Further, it was reported that maximum dairy farms were far from water source (65.0%) which implies that they had to cover larger distance carrying heavy buckets of water from the source to meet the daily requirement in the farms.

Table 1: Baseline description of the dairy workers based on work performed (n=360).

Variables	Parlor worker (n=180)	Non-parlor worker (n=180)	P value*
Age (years)			
<40	120 (66.6%)	96 (53.4%)	<0.001
Gender			
Male	99 (55.0%)	60 (33.4%)	0.08
Female	81 (45.0%)	120 (66.6%)	
BMI	22.8 $\pm$ 3.5	24.1 $\pm$ 2.4	0.55
Years into dairy occupation			
≤ 20 Years	111 (61.7%)	135 (75.0%)	0.04
>20 Years	69 (38.3%)	45 (25.0%)	

Continued.

Variables	Parlor worker (n=180)	Non-parlor worker (n=180)	P value*
Hours of work/ day			
<6	138 (76.6%)	99 (55.0%)	0.05
≥6	42 (23.4%)	81 (45.0%)	
Involved in alternate occupation	24 (13.3%)	36 (20.0%)	0.78
Dominant working hand - Right	180 (100.0%)	180 (100.0%)	0.68
Medical condition			
Known case of Diabetes	24 (13.4%)	32 (24.5%)	<0.001
Under treatment	12 (50.0%)	18 (75.0%)	
Known case of Hypertension	57 (31.6%)	66 (36.6%)	0.03
Under treatment	20 (36.8%)	21 (31.8%)	
Smoking tobacco (Both current and former)	48 (26.6%)	36 (20.0%)	0.56
Chewing tobacco (Both current and former)	156 (86.6%)	129 (71.7%)	0.33

*From Chi square test

Table 2: Description of dairy farms in the study (n=180).

Variables	Frequency
Type of cattle shed	
Close (all sides closed, with a door and without window)	147 (81.7%)
Open (open on one or more sides/ often with open spaces or window in the walls)	33 (18.3%)
Herd size per dairy household (average)	
Cow	4
Buffalo	1
Manual mode of milking	180 (100.0%)
Distance between the floor and cattle udder (cm)	144 - 160
Frequency of milking/ day	
Twice	126 (70.0%)
Thrice	54 (30.0%)
Mode of milk distribution –	
Walking	60 (33.3%)
Cycle	69 (38.3%)
Small truck	51 (28.4%)
Area within which milk is usually transported	
Very close to house	42 (23.4%)
Different ward	66 (36.6%)
Other zone	72 (40.0%)
Frequency of cleaning the cattle shed	
Daily	156 (86.6%)
Alternate days	24 (13.4%)
Floor type	
Concrete	18 (10.0%)
Mud	129 (71.7%)
Stone slab	33 (18.3%)
Distance from water facility	
Far from shed	117 (65.0%)
Near shed	63 (35.0%)

Overall, 96.7% workers reported experiencing work-related MSS in any anatomical site in this period; 88.4% reported MSS in two or more sites. Prevalence of MSS

was higher among the parlor workers (90.2%). Figure 1 illustrates the 12 months period prevalence of MSS among parlor and non-parlor dairy workers. Among the

333 workers reporting MSS, by body region, the highest prevalence was reported in the upper extremity region (48.1%) followed by lower extremity (28.5%) and neck and shoulder (23.4%). By specific body site, pain was reported in wrist (32.4%), shoulder (23.4%), upper back (18.3%) and elbows (15.3%) followed by feet (5.7%), hips and thighs (4.8%). It was noted that lower extremity symptoms were common among non-parlor workers while upper extremity and neck and shoulder MSS were common among parlor workers (Figure 1).

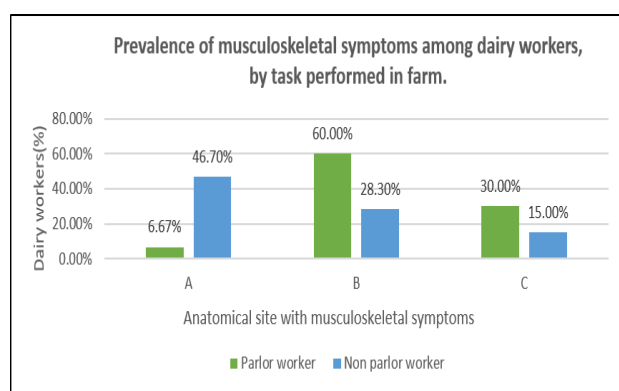


Figure 1: Prevalence of musculoskeletal symptoms among dairy workers, by task performed in farm.

However, of the 333 dairy workers reporting MSS, 296 workers mentioned experiencing symptoms of CTS, namely tingling, aching and numbness. Figure 2 represents the CTS reported by the dairy workers which shows majority parlor workers being affected; 30.0% reported tingling, 56.6% experienced aching and 18.3% reported numbness, in comparison to the non-parlor workers. Many workers had two or more CTS of right hand (since all have right hand dominance). The number of working hours per day ($p=0.054$) and gender of the worker ($p=0.02$) were found to have strong strength of association with CTS symptoms.

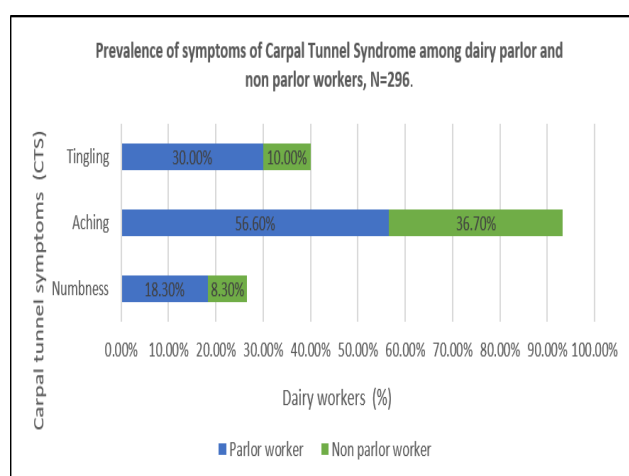


Figure 2: Prevalence of symptoms of Carpal Tunnel Syndrome among dairy parlor and non-parlor workers (N=296).

In addition, to the participants reporting MSS, Phalen's test was applied and Tinel's sign was checked, results as shown in Table 3. Overall, it was found that 51.7% dairy workers out of the entire sample were provisionally diagnosed with CTS. They were referred to Neuro-medicine department for further evaluation by NCS for conclusive diagnosis. Both Tinel's sign and Phalen's test were found positive in 42.3% and 63.1%, parlor and non-parlor workers, respectively.

Table 3: Results of Tinel's sign and Phalen's test to provisionally diagnose Carpal tunnel syndrome in dairy workers (n=296).

	Parlor worker (n=163)	Non-parlor worker (n=133)
Tinel's sign positive	117 (71.8%)	109 (81.9%)
Phalen's test positive	102 (62.6%)	89 (67.0%)
Tinel's sign and Phalen's test positive	69 (42.3%)	84 (63.1%)

The potential risk factors upon cross tabulation which were considered as possible confounders in the association between type of work at dairy farm and MSS among the dairy workers in this study sample were age, socioeconomic status, years into dairy occupation and time invested in dairy work. To know the predictors of association between type of work at farm and MSS, logistic regression was done. After adjusting for confounders, the odds of MSS among dairy workers doing parlor work is 3.44 times as compared to those performing non-parlor work (95%CI: 1.03-5.86, N=360) and the strength of association is strong ($p=0.045$) (Table 4). Upon adapting forward approach, the predictor variables- history of having diabetes and hypertension, were not fitted in the logistic model as their inclusion in model did not change effect estimate of exposure.

Table 4: Adjusted estimate of the odds ratio for type of work at dairy farm on MSS, estimated by logistic regression (n=333).

Exposure		Adjusted odds ratio*	95% confidence interval	P value**
Type of work at dairy farm	Non-parlor	1	-	0.045
	Parlor	3.44	(1.03-5.86)	

*Adjusted for socioeconomic status, age, years into dairy occupation and time invested in dairy work. **From the likelihood ratio test

DISCUSSION

It is a cross-sectional study, investigating the prevalence of MSS, CTS and ergonomic work factors among the

parlor and non-parlor workers in small-scale dairy farms using a validated screening tool, adapted in local language.

This study showed that the non-parlor workers were older (46.6%), females (66.6%), with less than 20 years of experience (75.0%) and spent more than 6 hours/ day in farm work while study with similar research objective showed that parlor-workers were older, worked longer hours (5 hours/week), had longer experience of working with dairy farming (10 years) in comparison to the non-parlor workers.²³ The dairy workers were mostly young, females being more involved in the non-parlor work which is maintaining cleanliness in farm and shed, feeding and bathing the cattle, lifting heavy milk cans, etc. in contrast to findings of previous studies where males were involved.^{2,4}

It is starkly evident from the prevalence of the MSS symptoms of 88.5% that the lack of mechanization and modification in equipment in this small-scale industry, even to the extent of lack of automatized milking and use of heavy milk vessels, is leading to complete dependence on strenuous and rigorous manual labour. Prevalence of MSS in current study is in line with results of previous studies.^{2,4,10} A study from Sweden shows the prevalence of MSS among parlor workers to be 85.0%, like our study where MSS was found to be more prevalent among the parlor workers (90.2%).¹⁹ These results are attributed to the lack of automatization in milking in current study and physical and ergonomic convenience in the Swedish study.¹⁹

However, due to high-quality standards expected from dairy industry in the Western world, inspite of mechanization, the man effort put in is considerably high. In India, the effort is skewed towards an expected level of farm maintenance, with most of the work being primarily manual.²⁰ While a previous Indian study shows the prevalence of CTS among dairy workers performing milking tasks was about 17%, after controlling for confounders, MSS was found to be more prevalent among the parlor workers in present study (aOR 3.55; 95%CI: 1.03-5.86).⁴ In contrast, previous study shows MSS severity to be higher among the non-parlor workers.²¹

Also, it has been demonstrated that manual milking, extreme work postures lasting for longer time, have led to developing musculoskeletal stress causing discomfort and loss in workdays.^{2-4,10,22} Similar to our study, MSS was found prevalent among young workers in another Indian setting and promoting musculoskeletal health among them stands beneficial to reduce occurrence of injuries and subsequently minimize absenteeism and turnover costs.⁷ In present study, most farms used aluminium milk cans of about 40 to 50 litres capacity to transport milk for selling; each can weighing about 6.6-8 kg (measured using calibrated weighing-scale). In-spice of the heavy weight being carried by non-parlour workers, MSS was more prevalent among parlor workers which can be

attributed to the repetitive hand and wrist motion involved in milching whereas the non-parlor work might not involve cyclic task putting strain on wrist and hands.⁴ This is strongly indicative of milching to be more strenuous and threat to musculoskeletal health, supported by report from Matthew et al where manual labour caused wrist and hand MSS.¹⁰

Moreover, in line with current study finding of 96.7% workers having MSS in at least one body part, Doupbrate et al report 76.4% parlor-workers with work-related MSS in at least one body part, with highest prevalence in upper extremity.²³ By specific body site, in accordance with current study where MSS was common in wrist (32.4%) and shoulder (31.8%), Nonnenmann et al reported majority of workers with shoulder MSS (54.0%) which may be due to the exposure to physical labour.⁵ This was in contrast to studies done in an organised dairy production unit of Surat and in Bangladesh, where lower back MSS was more common with prevalence of 32.0% and 81.8%, respectively.^{7,21}

Recently, there have been advancement in technology to reduce physical exertion among dairy workers and consequently decrease MSS prevalence but studies have shown MSS to be still associated with dairy work similar to current study.^{4,7,25} This similarity might be attributed to the preference of following conventional milking practice in small dairy farms due to the dearth of funds or lack of awareness regarding it. Ergonomic interventions including improved and adapted work tools and techniques should be adopted to reduce the prevalence of pain.

Strength

This study stands out as one of the rare investigations conducted among dairy workers in India, focusing on relatively unexplored aspect of occupational health in this population. It was a well-designed and well-executed cross-sectional study aiming to achieve a representative sample of target population to provide snapshot of prevalence of MSS at a specific point in time, making it efficient to assess immediate health status of the population.

Limitations

The questionnaire used was not a diagnostic tool and thus, could provide provisional diagnosis only. It recorded symptoms experienced in past 12 months, responses to which could be influenced by worker's emotional or physical status due to either ill health or work load. MSS are self-reported and introduces the potential for recall bias. The possibility of reverse causation exists, where MSS might influence the type of work chosen by worker rather than the other way around which could not be assessed since pre-occupation MSS are not explored. Information bias could not be excluded as the participants could know the purpose of study.

Societal factors influencing the perception and reporting of MSS may not have been completely explored. Exclusion of other family members involved in dairy farm within study period was a limitation leading to selection bias.

This might have resulted in underestimation of MSS prevalence. There could have been possible higher prevalence of MSS and stronger association of type of work and MSS and higher prevalence of MSS. The study may not have controlled for all potential confounding variables that could influence the association. It lacks generalisability as it included small sample size, small-scale farms only and only those who consented to participate. Effect on musculoskeletal health of workers in larger farms might differ due to ergonomic trainings or automatic milking. Recent old injury not considered and also other forms of task, like women performing household work, which are common in Indian society, was not taken into consideration.

CONCLUSION

Musculoskeletal symptoms are prevalent among dairy workers due to repetitive tasks, heavy lifting, stressful postures and prolonged time of standing. This stress leads to an impact on productivity since workers having musculoskeletal discomfort may have increased absenteeism, and diminished job satisfaction. This research explored specific risk factors such as ergonomic challenges and lack of mechanization to be crucial for developing MSS.

The evidence of strong association between parlor work and MSS, suggests MSS in small-scale dairy farms, requiring a proactive approach that includes task rotation as a key element. Task rotation would ensure each worker experiences balanced distribution of parlor and non-parlor responsibilities to prevent overexertion of specific muscle groups and reduces the likelihood of strain injuries. A structured schedule that mandate task rotation could prevent workers from following the trend of sustaining MSS at young age while doing parlor work and at later age, when harm is already done, they do non-parlor task. It would engage workers in activities with diverse ergonomic requirements, promoting a more balanced and ergonomic work routine. Flexible working hour policies must be implemented to allow workers adequate rest and recovery time. A system for workers should be established to provide feedback on the impact of task rotation and automated milking facility on their health. MSS among dairy workers needs a multifaceted approach, integrating ergonomic, technology, and psychosocial considerations.

Ergonomic interventions, like redesigning cattle shed, introducing assistive technologies, and effective lifting techniques to reduce the physical strain on dairy workers and understanding the psychosocial aspects, including job satisfaction, stress levels and the impact of organizational

culture on musculoskeletal health, might guide holistic interventions. Moreover, workers must be actively included in the decision-making process to ensure that the policies align with their physical capacities and preferences. Regular health assessment for workers, having specific focus on musculoskeletal health for early detection of symptoms must be conducted strictly to allow timely intervention and preventive measures. Future research should aim to contribute to the development of practical interventions and policy guidelines that enhance the musculoskeletal health and overall well-being of dairy workers.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Singh S, Kar S, Mishra A, Pattnaik D. Hygiene practices and awareness regarding milk-borne diseases (MBD) among dairy workers in unorganized urban settings of Bhubaneswar, Odisha, India. *Indian J Community Health*. 2021;33(3):466-74.
2. Kolstrup CL. Work-related musculoskeletal discomfort of dairy farmers and employed workers. *J Occup Med Toxicol*. 2012;7:23.
3. Park JH, Lim HS, Lee K. Work-related musculoskeletal symptoms among dairy farmers in Gyeonggi Province, Korea. *J Prev Med Public Health*. 2010;43(3):205-12.
4. Patil A, Rosecrance J, Doupbrate D, Gilkey D. Prevalence of carpal tunnel syndrome among dairy workers. *Am J Ind Med*. 2012;55(2):127-35.
5. Nonnenmann MW, Anton D, Gerr F, Merlino L, Donham K. Musculoskeletal symptoms of the neck and upper extremities among Iowa dairy farmers. *Am J Ind Med*. 2008;51(6):443-51.
6. Mokarami H, Varmazyar S, Kazemi R, Taghavi SM, Stallones L, Marioryad H, et al. Low cost ergonomic interventions to reduce risk factors for work related musculoskeletal disorders during dairy farming. *Work*. 2019;64(2):195-201.
7. Mishra N, Mayatra I, Patel K, Mishra A. A study to find work-related musculoskeletal disorders and associated risk factor among dairy workers. *Int J Yoga Physiother Phys Educ*. 2020;5(2):21-4.
8. Jakob MC, Rosecrance J. Editorial: international perspectives on health and safety among dairy workers: challenges, solutions and the future. *Front Public Health*. 2017;5:294.
9. Singh S, Kar S, Mishra A, Pattnaik D. Respiratory health of the small scale dairy workers of urban Bhubaneswar, Odisha. *Indian J Community Health*. 2022;34(3):431-4.
10. Doupbrate DI, Nonnenmann MW, Hagevoort R, Gimeno Ruiz de Porras D. Work-related musculoskeletal symptoms and job factors among

- large-herd dairy milkers. *J Agromedicine*. 2016;21(3):224-33.
11. Kamana O, Jaxsens L, Kimonyo A, Uyttendaele M. A survey on hygienic practices and their impact on the microbiological quality and safety in the Rwandan milk and dairy chain. *Int J Dairy Technol*. 2017;70(1):52-67.
12. Neeta PN, Prashanth N, Shivaswamy MS, Mallapur MD. A study on awareness regarding milk-borne diseases in an urban community of Karnataka. *Int J Med Sci Public Health*. 2014;3(9):1093-9.
13. Duguma B, Janssens GPJ. Assessment of dairy farmers' hygienic milking practices and awareness of cattle and milk-borne zoonoses in Jimma, Ethiopia. *Food Sci Qual Manag*. 2015;45:114-21.
14. Surkar SH, Sawarkar SW, Kolhe RP, Basunathe VK. Adoption of quality milk production practices by dairy farmers in Wardha district of Maharashtra. *Agric Rural Dev*. 2014;1(1):1-4.
15. Katz JN, Stirrat CR. A self-administered hand diagram for the diagnosis of carpal tunnel syndrome. *J Hand Surg Am*. 1990;15(2):360-3.
16. Bingham RC, Rosecrance JC, Cook TM. Prevalence of abnormal median nerve conduction in applicants for industrial jobs. *Am J Ind Med*. 1996;30(3):355-61.
17. Anton D, Rosecrance J, Merlino L, Cook T. Prevalence of musculoskeletal symptoms and carpal tunnel syndrome among dental hygienists. *Am J Ind Med*. 2002;42(3):248-57.
18. Rosecrance J, Cook TM, Anton D, Merlino L. Carpal tunnel syndrome among apprentice construction workers. *Am J Ind Med*. 2002;42(2):107-16.
19. Werner RA, Franzblau A, Gell N, Hartigan AG, Ebersole M, Armstrong TJ. Incidence of carpal tunnel syndrome among automobile assembly workers and assessment of risk factors. *J Occup Environ Med*. 2005;47(10):1044-50.
20. Armstrong T, Dale AM, Franzblau A, Evanoff BA. Risk factors for carpal tunnel syndrome and median neuropathy in a working population. *J Occup Environ Med*. 2008;50(12):1355-64.
21. Taghavi SM, Mokarami H, Ahmadi O, Stallones L, Abbaspour A, Marioryad H. Risk factors for developing work-related musculoskeletal disorders during dairy farming. *Int J Occup Environ Med*. 2017;8(1):39-45.
22. Phalen GS. The carpal-tunnel syndrome: clinical evaluation of 598 hands. *Clin Orthop Relat Res*. 1972;83:29-40.
23. Douphrate DI, Gimeno D, Nonnenmann MW, Hagevoort R, Rosas-Goulart C, Rosecrance JC. Prevalence of work-related musculoskeletal symptoms among US large-herd dairy parlor workers. *Am J Ind Med*. 2014;57(3):370-9.
24. Kamath V, Stothard J. A clinical questionnaire for the diagnosis of carpal tunnel syndrome. *J Hand Surg Br*. 2003;28(5):455-9.
25. Pinzke S, Stål M, Hansson GA. Physical workload on upper extremities in various operations during machine milking. *Ann Agric Environ Med*. 2001;8(1):63-70.

Cite this article as: Singh S, Kar S, Naik A. Understanding musculoskeletal symptoms in small-scale dairy employment: insights from a cross-sectional epidemiological study in Bhubaneswar, Odisha. *Int J Community Med Public Health* 2026;13:6459-66.