



OCCUPATIONAL SYMPTOMS AND PERSONAL PROTECTIVE EQUIPMENT GAPS AMONG SPICE-PROCESSING WORKERS IN NORTH INDIA: A CROSS-SECTIONAL STUDY

Public Health

Dr Sanidhya Bhargava*

Amrita School of Medicine, Amrita Vishwa Vidyapeetham, Faridabad, Haryana, India
*Corresponding Author

Dr Parteek Walia

Junior Resident, Department of Prosthodontics and Crown & Bridge, Kalinga Institute of Dental Sciences, Bhubaneswar, India

Dr. Aakanksha Gaba

Junior Resident, Department of Prosthodontics and Crown & Bridge, Kalinga Institute of Dental Sciences, Bhubaneswar, India.

ABSTRACT

Objective: To assess occupational symptoms and personal protective equipment gaps among spice-processing workers in North India. **Material and Methods:** A factory-based cross-sectional study was conducted among 120 workers from two spice-processing units in Pathankot, Punjab, and Damtal, Himachal Pradesh. Eligible production and packing workers were included by complete enumeration. Data were collected using a structured interviewer-administered questionnaire covering socio-demographic details, self-reported respiratory, ocular, dermatological, auditory, and musculoskeletal symptoms, and availability of personal protective equipment. Data were summarized using descriptive statistics. **Results:** Of 120 workers, 115 were male. Common respiratory symptoms were sneezing fits in 62 workers (51.7%), cough in 48 (40.0%), runny nose in 23 (19.2%), and wheeze in 21 (17.5%). Eye irritation and tired eyes were reported by 46 (38.3%) and 41 (34.2%) workers, respectively. Dry skin, burning sensation, and rashes were reported by 34 (28.3%), 31 (25.8%), and 19 (15.8%) workers. Musculoskeletal pain was common in the hip/leg/foot region (31.7%), shoulder/arm/hand (28.3%), and mid-back (26.7%). Excessive workplace noise was reported by 18 workers (15.0%). Mouth masks and boots were available in both factories, but eye protection, hearing protection, hard hats, and full-sleeve protective clothing were absent. **Conclusion:** Spice-processing workers reported considerable occupational symptoms and important protection gaps. Improved dust control, task-specific protective equipment, ergonomic measures, and occupational health surveillance are needed.

KEYWORDS

Spice Processing; Occupational Health; Dust Exposure; Respiratory Symptoms; Eye Irritation; Musculoskeletal Pain; Personal Protective Equipment; Cross-Sectional Study

INTRODUCTION

India's spice value chain relies heavily on small and medium processing units where grinding, blending, and packing generate complex bioaerosols and nuisance dusts. Exposures include capsaicinoids (e.g., capsaicin) and fine particulate matter from chili, paprika, garlic, onion, and mixed seasonings; these agents can irritate ocular and upper-airway mucosa and act as sensitizers in atopic workers, contributing to rhinitis, cough, asthma, and dermatitis. Empirical work over several decades—ranging from classic factory surveys to contemporary field evaluations—has consistently reported elevated rates of work-related eye and airway symptoms among spice-exposed workers, with across-shift decrements in lung function and documented IgE reactivity to spice allergens.(1–3)

Beyond respiratory and ocular irritation, case-series and plant investigations show that capsaicin-rich seasoning operations provoke acute symptoms (eye watering, sneezing, cough, dyspnea) and that poor respirator fit and lack of eye protection are common, particularly in small enterprises where engineering controls are limited. Reviews of spice-related particulate hazards further highlight dermatitis and allergic outcomes in addition to asthma, reinforcing the need for primary prevention via exposure control and effective PPE programs.(1,4)

Physical hazards also intersect with these exposures. Food-processing settings with similar task profiles (grinding, pouring, manual handling, prolonged standing) show a high burden of work-related musculoskeletal disorders (WRMSDs), and ergonomic interventions can reduce symptoms and incidents—evidence relevant to small spice units that often rely on manual processes.(5) Noise is another under-recognized co-exposure: Indian tea-processing plants—an analogous agro-processing environment with continuous machinery—report daily noise levels up to ~90 dBA with substantial prevalence of noise-induced hearing loss (NIHL) and near-universal non-use of hearing protection. Model Rules under India's Factories Act specify maximum permissible daily A-weighted exposures (e.g., 85 dBA for 8 h; 90 dBA for 4 h) and mandate hearing conservation when engineering/administrative controls are insufficient, standards that apply to spice processing as well.(6)

Despite this literature, recent data from Indian spice processors remain sparse, particularly for small-to-medium facilities that dominate the domestic market. There is limited documentation of symptom patterns

across organ systems (respiratory, ocular, dermal, musculoskeletal, and noise-related), and of the actual penetration and correctness of PPE use (respirators, eye and ear protection) under real-world conditions. To address this gap, we conducted a cross-sectional assessment among workers in two spice-processing factories in Punjab and Himachal Pradesh, quantifying self-reported work-related symptoms and describing protection practices to inform locally relevant preventive strategies.

Methods

This was a factory-based cross-sectional study conducted in two small-to-medium spice-processing units located in Pathankot, Punjab and Damtal, Himachal Pradesh, India. All workers present on survey days and engaged in production or packing were approached, and complete enumeration was attempted rather than sampling. Eligibility included current employment at either factory and ability to provide informed consent; administrative and clerical staff not exposed to processing areas were excluded. Data were collected during a single visit to each site using a structured, interviewer-administered questionnaire developed for this study, which captured socio-demographic characteristics (age, sex, education), site of work, and self-reported work-related symptoms across organ systems (ocular/eye irritation and tiredness; upper and lower respiratory symptoms including sneezing fits, cough, nasal discharge, wheeze or breathlessness; skin symptoms including dryness, burning, and rashes; auditory complaints including perceived high noise and difficulty hearing; other non-specific complaints). Musculoskeletal pain was recorded by body region (neck, shoulder/arm/hand, mid-back, lower back, hip/leg/foot). Personal protective equipment (PPE) availability and use were recorded as reported at each site (e.g., masks/respirators, gloves, boots, goggles, hearing protection, full-sleeve clothing) along with simple program features such as replacement of damaged PPE. The instrument was piloted on a small subset of workers at one site to confirm clarity of wording; minor language refinements were made before full administration. Interviews were conducted in the local language by trained field staff, and responses were marked contemporaneously on paper forms and subsequently entered into a spreadsheet-based database. Basic quality control included daily form review for completeness, range checks during entry, and logic checks to identify inconsistent answers (e.g., symptom reported as present with a zero duration).

The primary outcomes were binary indicators of self-reported symptoms in each domain and the distribution of musculoskeletal pain

by anatomical region. Secondary outcomes were simple counts of symptoms per worker within domains and reported PPE availability and use by site. Exposures of interest were limited to site (Factory-1 vs Factory-2) and reported PPE presence/use, recognizing that task-level exposure metrics (e.g., dust concentrations, specific spice handled, time in grinding versus packing) were not measured. No clinical examinations, spirometry, or environmental monitoring were undertaken. The analysis focused on descriptive epidemiology. Categorical variables were summarized as frequencies and percentages. Symptom prevalence was calculated using the total number of respondents as the denominator, except for variables with missing data, where available-case denominators were used. PPE availability and program features were summarized descriptively by factory. No inferential statistical testing or multivariable modelling was performed because the study was limited to two factories and important potential confounders, including task category, duration of employment, tobacco use, pre-existing respiratory disease, and measured dust or noise exposure, were not uniformly available. Exploratory analyses planned, contingent on cell sizes, included cross-tabulations of selected symptoms with reported mask use. No model-based adjustment was undertaken because potential confounders such as task category, tenure, or tobacco exposure were either unavailable or incompletely measured in the source dataset.

The study adhered to the principles of the Declaration of Helsinki and relevant national guidelines on research involving human participants. Institutional ethics approval was obtained from the Institutional Ethics Committee of Kasturba Medical College and Kasturba Hospital prior to data collection vide approval/reference number 731/2019. Written informed consent was obtained from all participants before data collection. Administrative permission to conduct the survey was obtained from the management of both factories. No personal identifiers were collected, and the data were analyzed and reported in aggregate form to maintain confidentiality.

RESULTS

We surveyed 120 spice-processing workers across two factories. Demographic distributions and symptom profiles are summarized in five tables, each followed by a detailed, descriptive note.

Table 1. Participant Characteristics (N=120 Unless Noted)

Characteristic	n	%
Sex		
Male	115	95.8
Female	5	4.2
Education		
No formal schooling	17	14.2
Primary	24	20.0
Secondary	51	42.5
Higher secondary	19	15.8
Graduate	9	7.5
Age group (available n=110)		
18–25 years	24	21.8
26–33 years	30	27.3
34–41 years	27	24.5
42–49 years	13	11.8
50–57 years	11	10.0
58–66 years	5	4.5

Of the 120 workers surveyed, 115 were male and 5 were female. Most workers had secondary-level education, followed by primary and higher-secondary education. Age information was available for 110 workers, with the majority belonging to the 26–33 and 34–41 year age groups.

Table 2. Respiratory and Ocular Symptoms (N=120)

Symptom	n	%
Respiratory		
Sneezing fits	62	51.7
Cough	48	40.0
Runny nose	23	19.2
Blocked nose	22	18.3
Wheeze	21	17.5
Breathlessness	14	11.7
Ocular		
Eye irritation	46	38.3
Tired eyes	41	34.2

Within respiratory items, the rank order is sneezing fits > cough > runny nose ≈ blocked nose > wheeze > breathlessness. The spread between the highest and lowest respiratory counts is 48 cases (62 vs 14). Ocular items follow the order eye irritation > tired eyes, with a difference of 5 cases (46 vs 41). Across the listed items, respiratory and ocular reports cluster in the upper end of the observed symptom frequencies.

Table 3. Dermatologic, Auditory, and Other Symptoms (N=120)

Symptom	n	%
Dermatologic		
Dry skin	34	28.3
Burning sensation	31	25.8
Oversensitivity to substances	20	16.7
Rashes	19	15.8
Auditory		
“Too much noise” at work	18	15.0
Difficulty hearing	6	5.0
Other		
Hoarseness	23	19.2
Chest tightness	17	14.2
Stomach/digestive problems	15	12.5

For dermatologic items, the descending order is dry skin > burning sensation > oversensitivity > rashes, with the top two items separated by 3 cases. For auditory items, perceived high noise reports outnumber difficulty hearing by a 3:1 ratio (18 vs 6). Among “other” complaints, the order is hoarseness > chest tightness > stomach or digestive problems, with a 6- to 8-case gap between successive items.

Table 4. Musculoskeletal Pain by Anatomical Region (N=120)

Region	n	%
Hip / leg / foot	38	31.7
Shoulder / arm / hand	34	28.3
Mid-back	32	26.7
Lower back	27	22.5
Neck	21	17.5

Musculoskeletal pain frequencies fall within a 17.5%–31.7% range across the five regions. The ordering is hip/leg/foot > shoulder/arm/hand > mid-back > lower back > neck. The top three regions are separated by at most 6 cases (38 vs 32), indicating relatively similar counts among these leading sites.

Table 5. Personal Protective Equipment (PPE) Availability and Program Features, by Factory

PPE Item/Program Feature	Factory-1	Factory-2	Notes
Mouth masks/respirators	Yes	Yes	Type/fit not documented
Work boots	Yes	Yes	
Gloves	Yes	No	Reported only in Factory-1
Replacement of damaged PPE	Yes	No	Only Factory-1 reported replacement
Eye protection (goggles/face shield)	No	No	
Hearing protection (ear muffs/plugs)	No	No	
Hard hats	No	No	
Full-sleeve protective clothing	No	No	

Items common to both factories are mouth masks/respirators and work boots. Items absent at both sites are eye protection, hearing protection, hard hats, and full-sleeve protective clothing. Differences between factories are limited to gloves and the replacement of damaged PPE, which were reported only at Factory-1.

DISCUSSION

In this two-factory survey of 120 spice-processing workers, the highest frequencies were for upper-airway and ocular symptoms (sneezing fits, cough, eye irritation, tired eyes), followed by dermatologic complaints, musculoskeletal pain across lower limbs/upper limb–shoulder girdle and back, and reports of high workplace noise with some difficulty hearing. Basic PPE was present (masks, boots), but eye and hearing protection were absent at both sites; gloves and any damaged PPE replacement practice were reported only at one site.

These symptom profiles align with published observations that spice dusts are irritant/sensitizing bioaerosols linked to rhinitis-like and bronchitic complaints, skin symptoms, and ocular irritation. A narrative review describes spice particulates as allergenic and combustible fine dusts relevant to worker health, consistent with our multi-system symptom pattern. Case-level and plant investigations from small spice operations report common sneezing, blocked/runny nose, cough, headache, and watering eyes, with authors explicitly noting these as “common among workers who are occupationally exposed to spices”. More recent retail-shop data show work-related eye complaints ($\approx 19.6\%$), runny nose ($\approx 22.3\%$), cough ($\approx 19.6\%$), and shortness of breath ($\approx 9.8\%$)—prevalences that sit within the spectrum of irritative outcomes reported in exposed groups. In classic factory work with hot-pepper exposure, cough was elevated among exposed employees and capsaicin cough-challenge responses supported an exposure–response signal. Biomarker studies from spice mills further link exposure with elevated FeNO (≥ 50 ppb) and serial FeNO changes in exposed workers, reinforcing an airway-inflammation signal in this sector. Together, these comparisons position our dataset within a well-described irritant/allergic symptomatology in spice handling. (7–10)

Dermatologic complaints in our data (dryness, burning, rashes) correspond to prior descriptions of skin problems during chilli cleaning/grinding and general reviews of occupational reactions to foods that include spice-related dermatoses. Reports from Indian informal-sector settings (tobacco/fish processing, weaving, construction, transport) also document high burdens of self-reported musculoskeletal, respiratory, eye, and skin problems, which is a relevant national context for small agro-processing work. Our musculoskeletal pain distribution (lower limb and upper limb–shoulder regions most frequent; mid/lower-back common) is descriptive, but the pattern is consistent with manual handling and prolonged standing reported in Indian small-industry syntheses. (9,11)

Auditory findings in our survey were limited to self-report, yet they coexist with objective evidence from analogous agro-processing: Indian tea-factory measurements documented area noise near ~ 90 dBA with measurable noise-induced hearing loss and limited hearing-protection use. In spice retail/processing settings evaluated by NIOSH, the highest inhalable dust was in grinding rooms; respirators were available but often worn incorrectly, and eye protection was inconsistently used, echoing our observation of rudimentary PPE programs without eye/ear protection.(12,13) From an occupational health perspective, the findings indicate that the existing protection measures may be insufficient for the range of hazards present in spice-processing work. The availability of masks and boots alone does not address ocular exposure, dermal contact, machinery-related noise, or ergonomic strain. A more comprehensive workplace protection strategy should include improved local exhaust ventilation or dust suppression, task-appropriate respiratory protection with fit and usage training, provision of goggles or face shields, hearing protection where noise levels are high, gloves and full-sleeve protective clothing for workers handling irritant spices, and regular replacement of damaged PPE. Periodic health screening, worker education, and workplace-level risk assessment would further strengthen prevention.

The study has certain limitations. First, symptoms were self-reported and were not confirmed through clinical examination, spirometry, peak expiratory flow monitoring, audiometry, dermatological assessment, or objective ergonomic evaluation. Second, environmental exposure measurements such as inhalable dust concentration, respirable particulate matter, specific spice allergen levels, capsaicin exposure, ventilation assessment, or noise dosimetry were not performed. Third, important determinants such as duration of employment, specific task category, tobacco use, pre-existing allergic or respiratory disease, and prior occupational exposure were not uniformly available, limiting analytical interpretation. Fourth, the study was restricted to two factories and may not be generalizable to all spice-processing units in India. Finally, the cross-sectional design prevents causal inference; therefore, the findings should be interpreted as evidence of symptom burden and protection gaps rather than proof of exposure-related disease.

Workers in two spice-processing factories reported a high burden of respiratory, ocular, dermatological, and musculoskeletal symptoms, along with important gaps in personal protective equipment availability and replacement practices. The findings highlight the need for occupational health interventions in small and medium spice-processing units, including improved ventilation and dust-control

measures, task-appropriate respiratory and eye protection, hearing conservation where machinery noise is present, regular PPE replacement, worker training, and ergonomic improvements. Future studies should incorporate objective exposure assessment, clinical evaluation, lung function testing, audiometry, task-wise risk classification, and longitudinal follow-up to better establish exposure–response relationships and guide preventive policies.

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