

# A pilot study approach on occupational disorders among metal craftsmen of Lalitpur, Nepal

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## ABSTRACT

**Introduction:** Metalcraft is a centuries-old tradition in Lalitpur, Nepal. Workers are exposed to various ergonomic and respiratory risks due to prolonged exposure to metal dust, fumes, and repetitive physical tasks. The present study aims to assess the pulmonary function and musculoskeletal complaints among metal craftsmen particularly involved in making sculptures.

**Methods:** A pilot cross-sectional study was conducted among 30 metal craftsmen purposively selected in Lalitpur Metropolitan City ward no. 6 and 17. Pulmonary Function Tests (PFT) were performed using a digital spirometer. Musculoskeletal discomfort was assessed using the standardized Nordic Musculoskeletal Questionnaire.

**Results:** 46.6% of metal craftsmen showed signs of respiratory disorders. Significant differences were found in % Predicted FEV1 and FEV1/FVC ratios ( $p < 0.05$ ) between the different types of work in which metal craftsmen were involved. Lower back discomfort was the most common musculoskeletal complaint, but differences across work types and hours were not statistically significant.

**Conclusion:** Occupational exposure among metal craftsmen may contribute to respiratory impairment. Musculoskeletal issues, although reported, were not significantly associated with work type or duration in this pilot sample. Further research with a larger sample is warranted.

**Keywords:** Ergonomics, Metal craftsmen, Musculoskeletal Disorders, Nepal, Occupational Health, Spirometry.

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## Introduction

The ethnic Newar community of Nepal, particularly Kathmandu and Lalitpur, has been involved in making ancient metal sculptures for centuries. Brass, bronze, and various alloys are highly used materials for making numerous Buddhist or Hindu idols.<sup>1</sup> The process involves

making a wax model of the desired statue and then casting it in metal. This technique requires precision and skill, and it takes several months to complete a single statue.<sup>2</sup> The involvement of strenuous, hand-intensive work increases the risk of upper limb musculoskeletal disorder

(MSD) among these metal craftsmen.<sup>2</sup> “Musculoskeletal disorders” include a wide range of inflammatory and degenerative conditions affecting the muscles, tendons, ligaments, joints, peripheral nerves, and supporting blood vessels.<sup>3</sup> These include clinical syndromes such as tendon inflammations and related conditions, nerve compression disorders (carpal tunnel syndrome, sciatica), and osteoarthritis, as well as conditions such as myalgia, low back pain and other regional pain. Body regions most commonly involved are the lower back, neck, shoulder, forearm, and hand.<sup>3</sup> Work-related musculoskeletal disorders (WMSDs) represent a set of diseases affecting the muscles, nerves, tendons, ligaments, joints, synovial sacs, cartilage, fascia and spinal discs, which originate from and are aggravated by poor working conditions or by methods adopted while engaging in work tasks.<sup>4</sup> Work-related musculoskeletal disorders affecting the back, lower limbs, and especially upper limbs and neck, can be extremely costly if not addressed appropriately.<sup>5</sup> Highly repetitive jobs that require grabbing, repetitive wrist bending, vibration, and localized mechanical strain are thought to be contributing factors to the development MSD affecting upper limbs.<sup>6</sup> An occupational disease is any chronic ailment contracted primarily as a result of an exposure to risk factors arising from work activity (WHO).<sup>7</sup> Occupational health hazards of metal craftsmen often includes musculoskeletal pain including back pain, knee pain, joint pain and also suffer from respiratory trouble like asthma due to dust of metal.<sup>7</sup> The process of handicraft metal work uses hazardous industrial processes of high-temperature melting, foundry work, beating, grinding, and machining; similar to hazard-prone industrial processes. Craftsmen are exposed to serious occupational and ergonomics-based hazards.<sup>8</sup> Different metals may be correlated with occupational hazards (toxicity, heat stress, and fumes), route of entry (inhalation, skin contact, and ingestion) and phase of hazard.<sup>8</sup> As hammering is the most predominant activity in the entire work process of metal idol crafts, a

large number of workers are engaged in this activity. Although metal craftwork has been practiced for many years, no such study of these works has been reported in Nepal so far. Thus, in the present study, the prevalence of upper limb MSD among these metal craftsmen engaged in strenuous, hand-intensive jobs will be evaluated. This study also evaluates the pulmonary function of these workers.

## Methods

This cross-sectional pilot study aims to evaluate musculoskeletal disorders and pulmonary function among metal craftsmen working in different areas of Lalitpur Metropolitan City. The study period was between July and August 2025. The study targeted 30 traditional metal craftsmen (e.g., bronze, copper, or brass workers) working in small workshops or household units in Lalitpur district, a known hub for metal art and craftsmanship. Metal craftsmen of age group 25-50 years in Lalitpur Metropolitan City with at least 5 years of experience in the given field were included in the study. The study population included metal craftsmen from selected wards of Lalitpur Metropolitan City, purposively chosen based on the concentration of metal working activities and accessibility. Workers who gave written consent and with at least five years of experience were included in the study whereas, subjects with history of heart disease, chronic respiratory disease, recent thoraco-abdominal surgery, recent ophthalmic surgery and subjects with physical abnormalities were excluded from the study. The metal craftsmen were divided into three groups based on the types of work they do:

1. Detail work- engraving, fine carving, chiseling
2. High-heat work- melting metal, casting, welding
3. Finishing work- Polishing

Permission from each selected participant was obtained prior to the studies through written consent. The study has been approved by the Institutional Ethics Committee, Sri Sri University

(IEC/SSU/017-2024), and the Nepal Health Research Council (Ref. no. 2964).

This research data is primary data collected using the Nordic Body Map questionnaire to measure musculoskeletal disorder complaints. In addition, the demographic data collected included age, gender, work experience, work hours per week, and work break hours. Pulmonary Function test was performed using a spirometer ('MEDSPIROR' RMS recorder and medicare system, Chandigarh, India) between 9 a.m. and 12 p.m. Spirometry assessments were performed according to American Thoracic Society/European Respiratory Society standards. The spirometer is supplied with software that makes corrections for age, sex, weight, height, and ambient temperature to the given parameter. Subjects were instructed to take a deep breath and blow into the disposable mouthpiece as quickly and forcefully as possible. A nasal clip was applied over the nose to ensure breathing through the mouth alone. Subjects were

instructed to press their lips tightly around the mouthpiece. Forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC, and peak expiratory flow rate (PEFR) were measured. The best of the three readings was considered for analysis. For normal lung function tests, predicted percentage of  $\geq 80\%$  for FVC and FEV1 and FEV1/FVC ratio of  $\geq 0.7$  were considered cut-off values. Obstructive lung function was defined as having FEV1  $< 80\%$  of predicted and FEV1/FVC  $< 0.7$  and restrictive lung function was defined as having FVC  $< 80\%$  of predicted and FEV1/FVC  $\geq 0.7$ .<sup>9</sup> Statistical analysis was done using Statistical Package for the Social Sciences SPSS v. 17. Descriptive statistics were used to analyze the demographic variables. Mean, standard deviation, frequency, and percentage were calculated. Student's t-tests and chi-square tests were used to determine significant differences between the parameters of two groups. A p-value less than 0.05 was considered statistically significant.

## Results

Demographic variables related to the study population primarily including age, height, weight are presented in Table 1. All the participants in the study were men, age ranging 25-49 years with average work experience of 16.13 years. The working hours ranges 36-78 hours per week with a break of an hour per day.

The working posture of the metal craftsmen is long hours of repetitive, and awkward postures

that include forward neck bending, stooped/bent-back posture, sitting on floor cross legged or squatting, repetitive wrist flexion/extension. According to questionnaire, musculoskeletal discomfort was prevalent among metal handicraftsmen. The findings indicated that lower back was the most frequently reported region of musculoskeletal discomfort as shown in Table 2.

**Table 1:** Demographics of the metal handicraft workers (n=30)

Variables	Metal Handicraft workers (M±SD)
Age (years)	36.96±8.02
Height (cm)	165±4.73
Weight (kg)	68.16±8.74
Duration of work per week (hours)	59.60±14.99
Duration of rest per day (hours)	1
No. Of working days in a week	6
Working experience (in years)	16.13±7.69

Notes: M±SD, Mean and Standard Deviation



Figure 1: Working posture of metalcraftsmen

Table 2: Frequency of body region discomfort

Body Region	Frequency (%)
Lower Back	27 (90%)
Neck	10 (33.33%)
Wrists/Hands	9 (30%)
Knees	6 (20%)
Elbows	6 (20%)
Upper Back	4 (13.3%)
Shoulders	3 (10%)
Hips/Thighs	3 (10%)
Ankle	1 (3.33%)

Table 3: Pulmonary functions comparison among types of metal craftsmen

Parameter	Engraver (n = 20) Mean ± SD	Melting/Casting/Welding (n = 5) Mean ± SD	Polishing (n = 5) Mean ± SD
FEV1 (L)	2.98 ± 1.05	1.48 ± 0.86	3.29 ± 0.93
FVC (L)	3.65 ± 1.11	3.14 ± 0.95	3.88 ± 1.16
FEV1/FVC (%)	82.05 ± 13.12	55.85 ± 39.75	85.10 ± 4.99
% Predicted FEV1	91.04 ± 24.62	48.01 ± 27.35	89.05 ± 20.07
% Predicted FVC	96.29 ± 24.44	93.14 ± 41.17	87.61 ± 15.79
PEFR (L/min)	367.0 ± 145.2	278.8 ± 124.1	456.1 ± 131.8
FEF 25% (L/s)	4.83 ± 2.07	4.00 ± 1.62	5.35 ± 0.86
FEF 50% (L/s)	4.36 ± 1.48	3.14 ± 0.98	4.14 ± 0.93
FEF 75% (L/s)	2.71 ± 1.16	1.76 ± 0.50	2.90 ± 1.03

The study showed significantly lower FEV1, FVC, FEV1/FVC, % predicted FEV1 and % predicted FVC in workers who are involved in high heat and metal fume exposure type of work (melting metal, casting welding) as shown in Table 3. The

study showed a significantly lower FEV1, FVC, FEV1/FVC, PEFR, FEF 25% and FEF 75% in workers with longer exposure of more than 15 years of working experience as shown in Table 4.

PFT parameters	Less than 15 years (Mean±SD)	More than 15 years (Mean±SD)	t value	df	p value
FEV1 (L)	3.54±0.785	2.299±1.052	3.701	27.995	0.001
FVC	4.13±0.839	3.247±1.114	2.477	27.999	0.020
FEV1/FVC (%)	86.218±5.587	73.778±23.945	2.070	18.236	0.053
% Predicted FEV1	93.996±16.489	77.951±32.515	1.760	24.828	0.091
%Predicted FVC	94.046±14.363	94.1981±32.515	-.018	23.681	0.986
PEFR (L/min)	446.323±127.166	317.059±135.631	2.680	26.767	0.012
FEF 25% (L/s)	5.699±1.570	4.154±1.771	2.524	27.312	0.018
FEF 50% (L/s)	4.62±1.549	3.788±1.112	1.645	20.890	0.115
FEF 75% (L/s)	3.087±1.163	2.261±0.936	2.094	22.648	0.048

**Table 4:** Pulmonary Functions comparison according to years of working experience

## Discussion

The majority of workers reported experiencing pain and discomfort related to musculoskeletal disorders, with the lower back being the most commonly reported area of body pain, according to the results of the Standardized Nordic questionnaires, which are displayed in Table 2 for the analysis of musculoskeletal symptoms.

According to the study, workers are working in a forward-bending posture for extended periods of time without taking appropriate breaks throughout the day. These prolonged sitting and bending posture, can definitely cause musculoskeletal strains and negatively affect health.<sup>10,11</sup>

In a similar study done in India to evaluate the prevalence of upper limb musculoskeletal disorders among brass metal workers, it was

found that that high repetitiveness, prolonged work activity (10.5 h of work per day with 8.4 h spent on hammering) and decreased handgrip strength may be causative factors in the occurrence of upper limb MSD.<sup>2</sup> A study done in India to assess the work-related musculoskeletal disorder among Goldsmiths found that these workers suffer from occupational disorders like pain at neck, shoulder, wrist, and low back and also eye problem like irritation and burning sensation.<sup>12</sup> These musculoskeletal issues also lower productivity at work.<sup>13,14</sup>

This study also evaluated the pulmonary functions of the metal craftsmen. We could not find any study which is previously done to assess pulmonary functions among metal craftsmen involved in making metal statues and sculptors.

A study conducted in Iran to assess respiratory health and cross-shift changes among foundry workers found that lung function values for FVC and FEV1 were significantly lower in the exposed group compared with the unexposed office workers group.<sup>15</sup> The majority of airborne pollutants, like dust and metal fumes, have been demonstrated to negatively impact exposed workers' lung function.<sup>16</sup>

In a study conducted in Malaysia to evaluate respiratory symptoms, spirometric lung patterns, and metal fume concentrations among welders, it was found that 60.71% of welders had normal lung function, followed by obstructive and restrictive, with 3.57% and 35.71%, respectively.<sup>17</sup> In the present study, the significantly lower PFT parameters, as shown in Table 2, were observed among workers in the melting metal, casting, and welding group, indicating a higher respiratory risk, likely attributable to prolonged exposure to metal fumes, high temperatures, and potentially inadequate respiratory protection. This highlights the need for improved occupational safety measures in these high-risk subgroups.

A significantly lower FEV1 in workers with longer exposure, as shown in Table 3, indicates a decline in lung function associated with chronic exposure to metalworking environments. Also, a significantly lower FVC suggests a reduction in the total air exhaled by long-term-exposed workers, which may imply restrictive or mixed-type impairments. A significant decline in PEFV indicates reduced expiratory power, potentially linked to obstructive airway diseases. A reduction in Forced Expiratory Flow at 25% of

FVC reflects deterioration in small airway function with prolonged exposure. Reduction in FEF 75% indicates possible late-phase airway obstruction in long-term exposed individuals.

## Conclusion

The findings highlight the occupational health risks faced by traditional metalworkers. The majority of metal craftsmen had WMSDs in different body regions, with lower backache being the most common. Also, the study found the decline in respiratory function parameters among the metal craftsmen.

## Limitations

Under-reporting or over-reporting of symptoms due to factors like fear of job loss, or lack of awareness of their condition, was the major limitation of the study. Also, objective measurements (such as biomechanical analyses or workstation assessments) are not included in the study due to resource constraints or a lack of equipment, which may reduce the study's quality.

## Ethical Consideration

Informed and written consent was obtained from all participants. Ethical clearance was also obtained from Sri Sri University and Nepal Health Research Council for the full-scale study.

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## References

1. Shakya S. The Metal Art in Nepal. *Lumbini Prabhā*. 2019;4(1). Available from: [https://www.academia.edu/43217223/The\\_metal\\_Art\\_in\\_Nepal\\_Sanjay\\_Shakya\\_Background](https://www.academia.edu/43217223/The_metal_Art_in_Nepal_Sanjay_Shakya_Background)
2. Gangopadhyay S, Ghosh T, Das T, Ghoshal G, Das BB. Prevalence of upper limb musculoskeletal disorders among brass metal workers in West Bengal, India. *Industrial health*. 2007;45(2):365-70. Available from: <https://doi.org/10.2486/indhealth.45.365>
3. Punnett L, Wegman DH. Work-related musculoskeletal disorders: the epidemiologic evidence and the debate. *Journal of electromyography and kinesiology*. 2004;14(1):13-23. Available from: <https://doi.org/10.1016/j.jelekin.2003.09.015>

4. Bispo LG, Moreno CF, de Oliveira Silva GH, de Albuquerque NL, da Silva JM. Risk factors for work-related musculoskeletal disorders: A study in the inner regions of Alagoas and Bahia. *Safety Science*. 2022;153:105804. Available from: <https://doi.org/10.1016/j.ssci.2022.105804>
5. Yassi A. Work-related musculoskeletal disorders. *Current opinion in rheumatology*. 2000;12(2):124-30. Available from: <https://doi.org/10.1097/00002281-200003000-00006>
6. Gangopadhyay S, Ray A, Das A, Das T, Ghoshal G, Banerjee P, Bagchi S. A study on upper extremity cumulative trauma disorder in different unorganised sectors of West Bengal, India. *Journal of occupational health*. 2003;45(6):351-7. Available from: <https://doi.org/10.1539/joh.45.351>
7. Ganguly M, Patsa MK, Ghosh A, Ganguly A. An insight to the bell metal industry of Bankura, West Bengal, India. *Int. J. Life Sci*. 2016;5(2):105-11. Available from: [https://www.academia.edu/70624950/An\\_Insight\\_to\\_the\\_Bell\\_metal\\_Industry\\_of\\_Bankura\\_West\\_Bengal\\_India](https://www.academia.edu/70624950/An_Insight_to_the_Bell_metal_Industry_of_Bankura_West_Bengal_India)
8. Pati S. Evaluating Occupational Health and Safety (OHS) Issues for Craftsmen in Metal Handicrafts. *Research into Design for a Connected World. Smart Innovation, systems and technologies, Volume 135*. Springer Singapore. 2019:439-49. Available from: [https://doi.org/10.1007/978-981-13-5977-4\\_37](https://doi.org/10.1007/978-981-13-5977-4_37)
9. Celli BR, MacNee WA, Agusti AA, Anzueto A, Berg B, Buist AS, et al. Standards for the diagnosis and treatment of patients with COPD: a summary of the ATS/ERS position paper. *European Respiratory Journal*. 2004;23(6):932-46. Available from: <https://doi.org/10.1183/09031936.04.00014304>
10. Rasoulivalajoozi M, Rasouli M, Cucuzzella C, Kwok TH. Prevalence of musculoskeletal disorders and postural analysis of beekeepers. *International Journal of Industrial Ergonomics*. 2023;98:103504. Available from: <https://doi.org/10.1016/j.ergon.2023.103504>
11. Demissie B, Bayih ET, Demmelash AA. A systematic review of work-related musculoskeletal disorders and risk factors among computer users. *Heliyon*. 2024;10(3):e25075. Available from: <https://doi.org/10.1016/j.heliyon.2024.e25075>
- Ghosh T, Das B, Gangopadhyay S. Work-related musculoskeletal disorder: an occupational disorder of the goldsmiths in India. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*. 2010;35(2):321-5. Available from: <https://doi.org/10.4103/0970-0218.66890>
12. Bai Y, Kamarudin KM, Alli H. A systematic review of research on sitting and working furniture ergonomic from 2012 to 2022: Analysis of assessment approaches. *Heliyon*. 2024;10(7):e28384. Available from: <https://doi.org/10.1016/j.heliyon.2024.e28384>
13. Oestergaard AS, Smidt TF, Sogaard K, Sandal LF. Musculoskeletal disorders and perceived physical work demands among offshore wind industry technicians across different turbine sizes: A cross-sectional study. *Int J Ind Ergon*. 2022;88:103278. Available from: <https://doi.org/10.1016/j.ergon.2022.103278>
14. Saraei M, Masoudi H, Aminian O, Izadi N. Respiratory health and cross-shift changes of foundry workers in Iran. *Tanaffos*. 2018;17(4):285-90. Available from: <https://pmc.ncbi.nlm.nih.gov/articles/PMC6534795/>
15. Evaluation of impairment/disability secondary to respiratory disorders. *American Thoracic Society. Am Rev Respir Dis*. 1986;133(6):1205-9. Available from: <https://cir.nii.ac.jp/crid/1571135650277253248>
17. Bakri SF, Hariri A, Ismail M, Abdullah S, Kassim NI. Evaluation of respiratory symptoms, spirometric lung patterns and metal fume concentrations among welders in indoor air-conditioned building at Malaysia. *International Journal of Integrated Engineering*. 2018;10(5):109-21. Available from: <https://doi.org/10.30880/ijie.2018.10.05.017>