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Low Back Pain and Associated Factors among Workers in The Blacksmithing Industry in Java, Indonesia

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Abstract

Background: Low back pain (LBP) is a common musculoskeletal disorder among informal sector workers, including blacksmiths. particularly because of non-ergonomic work positions.
Objective: This study aims to identify the prevalence of low back pain (LBP) and its associated characteristics among blacksmith workers in Mekarmaju Village, Bandung Regency**.**
Methods: A cross-sectional study was carried out among 105 blacksmiths with interview, the Bodymap Discomfort questionnaire, the Visual Analogue Scale (VAS), physical examination, and measurement of trunk flexion angle using APECS version 8.05.07. In this study, LBP among blacksmith workers was characterized as chronic non-specific low back pain.
Results: LBP prevalence among blacksmiths was 58.1%. Factors significantly associated with LBP included forward-bending posture (p=0.034; aOR 3.7; 95% CI 1.1–12.5), static sitting posture for ≥4 hours (p=0.009; aOR 3.6; 95% CI 1.4–9.4), rest duration <0.5 hours (p=0.006; aOR 7.9; 95% CI 1.8–35.3), and age ≥35 years (p=0.006; aOR 4.6; 95% CI 1.6–13.6). Other occupational and individual factors didn't have a significant correlation with LBP.
Conclusion: These results indicate the necessity for immediate ergonomic interventions and health assessments at the beginning of employment for preventing LBP among informal sector workers.
Keywords: low back pain, blacksmiths, video analysis, APECS, ergonomics

Abstrak

Latar Belakang: *Nyeri punggung bawah (NPB) adalah gangguan muskuloskeletal yang umum terjadi pada pekerja sektor informal, salah satunya pandai besi, terutama akibat postur kerja yang tidak ergonomis.*
Tujuan: *Penelitian ini bertujuan untuk menentukan prevalensi dan faktor-faktor terkait NPB pada pekerja pandai besi di Desa Mekarmaju, Kabupaten Bandung*
Metode: *Menggunakan desain cross-sectional pada 105 pekerja pandai besi melalui interview, pengisian Bodymap Discomfort, Visual Analogue Scale (VAS), pemeriksaan fisik,dan pengukuran sudut membungkuk menggunakan APECS versi 8.05.07. NPB pada pandai besi adalah NPB kronis nonspesifik dengan nyeri pada area lumbal selama ≥3 bulan, skor VAS ≥3, disertai spasme otot, serta hasil uji Lasegue, Patrick, dan Contrapatrick negatif.*
Hasil: *Prevalensi NPB pada pekerja pandai besi adalah 58,1%. Faktor yang berhubungan adalah postur membungkuk (p=0.034; aOR 3,7; 95%CI=1,1 s/d 12,5); postur duduk statis ≥ 4 jam (p=0,009; aOR 3,6; 95%CI=1,4 s/d 9,4); waktu istirahat <0,5jam (p=0.006; aOR 7,9; 95%CI=1,8-35,3) dan usia ≥ 35 tahun (p=0,006; aOR 95%CI= 4,6; 1,6-13,6). Faktor pekerjaan lain dan faktor individu lain tidak berhubungan signifikan.*
Kesimpulan: *Penelitian ini menunjukkan bahwa intervensi ergonomi dini dan pemeriksaan kesehatan di awal masa kerja sangat penting untuk mencegah NPB pada pekerja sektor informal.*
Kata Kunci*: nyeri punggung bawah, pandai besi, video analysis, APECS, ergonomi*

Introduction

Low back pain (LBP) was the leading cause of disability globally, with 619 million cases in 2020 It is a major occupational health issue, especially in MSMEs (Micro, Small, and Medium Enterprises), where workers perform tasks like heavy lifting, prolonged bending, static postures, and repetitive movements. In Indonesia, the prevalence of LBP varies between 38.4% and 75%.[1,2] A prior study indicated that 52.4% of blacksmiths in Riau suffered from low back pain, representing a significant burden of musculoskeletal disorders among traditional metalworking sectors.[3]

Despite the significance of the issue research on low back pain (LBP) among blacksmith workers remains limited, with previous studies predominantly relying on subjective questionnaires without physical examination.[3,4] This study investigates occupational and individual factors associated with LBP among informal blacksmith workers in Ciwidey Village, Bandung, focusing on posture, work characteristics, and individual factors. An objective ergonomic assessment was performed using video analysis and physical examination, with posture angles measured using the AI Posture Evaluation and Correction System (APECS), a validated instrument for evaluating body posture and joint angles.[5] The results are expected to support practical interventions aimed at mitigating LBP risk and avoiding long-term health, productivity, and financial effects among blacksmith workers.

Most of the blacksmithing in Mekarmaju Village is done by informal micro, small, and medium enterprises that hire about 300 workers to work in small workshops. This village makes about 500 items a day, such as knives, machetes, and hoes, using manual methods such as forging, grinding, and making handles or sheaths. During the production process, iron is heated and hammered into shape, then finished with mechanical grinding. Then they do manual crafting of wooden handles and sheaths. During these activities, workers are faced to high temperatures, tool vibrations, and extended non-ergonomic postures with inadequate relaxation during these tasks. These conditions impose continuous mechanical stress on the spine and increase the risk of low back pain (LBP).[6] As a result, LBP ranks among the top 10 diseases reported at the local health center. LBP in blackmith is commonly chronic and non-specific. It is characterized by pain in the area between the lower posterior edge of the rib cage and the horizontal gluteal fold, extending from the lowest ribs to the buttocks, which may be localized or radiate to the legs. It is persistent lower back pain lasting ≥ 3 months without an identifiable specific cause.[7]

A preliminary study among blacksmith workers in Mekarmaju Village conducted between August and September 2024 among 300 blacksmith showed that low back pain was the second most common health condition in the blacksmith community of Ciwidey, affecting 64% of the total population of 300 workers (higher than the prevalence reported in previous studies at 52.38%). In addition, low back pain was ranked among the top ten diseases recorded at the Village X Primary Health Center based on data from June to August 2024, thereby contributing to a significant healthcare cost burden due to the need for long-term treatment. These results highlight the need for further investigation into specific risk factors within the work environment.

Given these gaps, there is a need for a more objective and comprehensive evaluation of ergonomic risk factors associated with LBP in blacksmith workers. This study aims to identify and analyze risk factors contributing to the occurrence of low back pain among blacksmith workers in Village X, Ciwidey, Bandung Regency, by determining the prevalence of low back pain and examining the associations between occupational factors such as forward-bending posture, static sitting or standing postures, use of forging hammers, work duration, length of employment, rest periods, and production volume and individual factors including age, educational level, body mass index, and lifestyle habits such as physical activity and smoking, with the incidence of low back pain. The results of this study are expected to form the basis for ergonomic interventions and preventive policy recommendations to improve occupational health in the informal sector.

Methods

This study was carried out in Blacksmith Workshop in Ciwidey Village between March and June 2025 using observational analytical cross-sectional design. Inclusion criteria are male blacksmiths aged over 18 years who have worked for at least 6 months. Exclusion criteria are individuals with existing back pain, a history of back pain, or known spinal abnormalities. This study examines Low Back Pain (LBP) as the dependent variable, with independent variables including

occupational factors (posture, work experience, production volume, work duration, rest time, static postures, hammer use) and individual factors (age, BMI, education, exercise, smoking habits).

This study used purposive sampling based on the number of neighborhood units (Rukun Warga, RW) with the largest blacksmith populations. Two RWs were selected to meet the minimum required sample size. RW 3 and RW 11, which had the greatest number of blacksmiths. The final sample comprised 106 participants, including 73 workers from RW 3 and 33 workers from RW 11.

The procedure involved interview for LBP, Body Discomfort and VAS assessments, followed by physical and anthropometric examinations. Bending analysis was done using smartphone videos and the APECS 8.4.17 app, recorded from a 90° side angle during one product cycle. APECS has been validated in studies conducted in India.[5] Furthermore, APECS has been widely used in many research studies to assess and quantify body posture and joint angles in both workers and general population.[8] APECS (*AI Posture Evaluation and Correction System*) version 8.05.07 is used to objectively measure trunk flexion angles from side-view video recordings during work cycles. The video was processed to evaluate bending posture, generating a graph of spine-to-hip angles. Although APECS was originally validated among an Indian population, its application in this Indonesian study is justified for several reasons. APECS measures trunk flexion angles objectively through AI-based detection of anatomical landmarks from side-view video recordings, meaning its measurement output is based on universal biomechanical geometry rather than population-specific norms or anthropometric references. The biomechanical principles underlying trunk flexion and its association with low back pain risk are well-established and consistent across populations regardless of ethnicity or geographic origin. Furthermore, APECS has demonstrated cross-cultural applicability beyond its original validation context, having been used among physiotherapists in Pakistan and workers in various occupational settings across different countries, supporting its use as a reliable posture assessment tool in diverse populations, including Indonesian blacksmith workers.[8]

Specific LBP exams included spinal inspection, ROM tests, and palpation for pain or spasms, along with neurological tests (Laseque, Patrick, and Contra-Patrick). LBP in this study refers to chronic non-specific LBP, defined as pain localized in the area between the lower posterior edge of the rib cage and the horizontal gluteal fold during the survey, with a history of pain occurring almost daily for at least 3 months, VAS score ≥ 3, and the presence of muscle spasms or contractions identified through physical examination. The results of the Laseque, Patrick, and Contrapatrick tests were negative.[7] When hip flexion is less than 45 degrees, the Laseque Test, which is used to evaluate lower back discomfort, is deemed positive. The sciatic nerve is stretched during this examination, and if it becomes irritated, pain will radiate down the leg. When doing the Patrick (FABER) Test, the patient lies down and the tested leg is positioned in the Flexion, Abduction, External Rotation (FABER) posture. If the patient experiences pain in the lower back or pelvis, this indicates disease in the hip articulation or sacroiliac joint, such as arthritis, dysfunction of the sacroiliac joint, or other problems.[9] The Contrapatrick Test is performed by applying pressure to the opposite side of the hip while the patient's leg is in a similar position, and the result is considered positive if the patient experiences pain in the pelvic or lower back area, suggesting issues with the hip or sacroiliac joint.[10] The researcher conducted the examination and interview. All clinical interviews and physical examinations were conducted by a single examiner the primary researcher, a physician with training in occupational medicine to ensure consistency throughout the data collection process. Prior to data collection, a standardization session was conducted in which the examiner reviewed and rehearsed the structured interview protocol and physical examination procedures, including spinal inspection, range-of-motion testing, palpation, and neurological tests (Laseque, Patrick, and Contrapatrick), according to a pre-defined standard operating procedure. The use of a single examiner eliminated inter-examiner variability; however, the potential for intra-examiner variability is acknowledged as a study limitation.This study received ethical approval from the FKUI-RSCM Ethics Committee Number: KET-315/UN2.F1/ETIK/PPM.00.02/2025

Result

This study included 106 respondents, with one dropout because of a neurological abnormality found by positive Lasegue and Patrick tests. The remaining 105 respondents

qualified the inclusion criteria: male blacksmiths aged over 18 years, have at least 6 months of work experience, and no history of back pain, current back pain, or known spinal abnormalities. Interview for low back pain (LBP), Body Discomfort and Visual Analog Scale (VAS) assessments, physical and anthropometric tests to diagnose LBP, and video analysis to evaluate bending posture using the APECS 8.4.17 application were among the data gathering techniques applied.

According to the data received and the clinical examinations, 61 employees (58.1%) were diagnosed with chronic non-specific LBP, which is defined as pain that is localized between the lower posterior rib margin and the gluteal fold, occurring almost daily for at least three months, with a VAS score ≥3 and the presence of muscle spasm on physical examination. Lasegue, Patrick, and Contrapatrick tests showed up negative. The high physical workload and inadequate preventive measures, such as inadequate ergonomic posture training, are highlighted by the observed prevalence of 58.1%. This emphasizes the necessity of focused interventions to enhance workplace ergonomics and lower employees' risk of developing musculoskeletal diseases.

The distribution of respondent characteristics in this study revealed that the majority of workers were aged 35 years or older (75.2%) and had a normal BMI (71.4%). The vast majority (91.4%) had completed only an elementary or junior high school education. Smoking habits were predominantly light, with 66.7% of workers being light smokers. A significant portion (73.3%) reported poor exercise habits. In terms of work conditions, 70.5% of respondents worked less than 8 hours per day, and 82.9% had less than 0.5 hours of rest during their shifts. The majority (95.2%) had been employed for 5 or more years. Regarding posture, 82.9% of workers spent 200 or more minutes in a bent posture, and 57.1% sat statically for less than 4 hours. All workers (100%) reported standing for less than 4 hours during their shifts, and none used forging hammers at a frequency of ≥120 times per minute or with a weight ≥2.5 kg.

Table 1. Prevalence of low back pain (LBP)

Variables	n = 105 n (%)
Low Back Pain	
Yes	61 (58,1)
No	44 (41,9)

Table 2. Distribution of respondent characteriztic

Variables	n = 105 n (%)
Demographics	
Age	
≥ 35 Years	79 (75,2%)
< 35 Years	26 (24,8%)
BMI	
Overwight	30 (28,6%)
Normal	75 (71,4%)
Education level	
Elementary and Junior High School	96 (91,4%)
Senior High School	9 (8,6%)
Habits	
Smoking Habits (Brinkman Index)	
Moderate-heavy smoker	35 (33,3%)
Light smoker	70 (66,7%)
Exercise Habits	
Poor	77 (73,3%)
Good	28 (26,7%)
Occupational factors	
daily production quantity (pieces)	50 (5-150)
Work duration (hours)	
≥ 8	31 (29,5%)
< 8	74 (70,5%)
Rest time (hours)	
< 0,5	18 (17,1%)
≥ 0,5	87 (82,9%)
Employment duration (years)	
≥ 5	100 (95,2%)
< 5	5 (4,8%)
Posture	
Bent posture	
≥ 20^0	87 (82,9%)
< 20^0	18 (17,1%)
Static sitting posture (hours)	
≥ 4	45 (42,9%)
< 4	60 (57,1%)
Static standing posture (hours)	
≥ 4	0 (0%)
< 4	105 (100%)
Use of forging hammer	
≥120 x/minute and weight ≥ 2.5 kg	0 (0%)
<120 x/minute and weight < 2.5 kg	105 (100%)

The multivariate logistic regression analysis shown in Table 3 revealed important variables linked to blacksmith workers' likelihood of developing low back pain (LBP). Static sitting posture increased the risk of LBP by 3.6 times (aOR 4.6; CI 1.4–9.4), whereas bent posture increased the risk by 3.7 times (aOR 3.7; CI 1.1–12.5). Less than half an hour of rest was linked to a 7.9-fold increased risk of lower back pain (aOR 7.9; CI 1.8–35.3). Additionally, it was discovered that LBP was 4.6 times more common among workers 35 years of age and older (aOR 4.6; CI 1.6–13.6). These results emphasize the urgent need for focused interventions that address these ergonomic and work-related risk factors, especially for older workers and those with bad posture and little downtime. The risk of LBP in this occupational category can be considerably decreased by addressing these factors through ergonomic education, appropriate work practices, and adequate rest times.

Discussion

In this study, the prevalence of low back pain (LBP) was found to be 58.1% among 105 blacksmiths in Ciwidey, which is higher compared to a similar study by Ferdi Hidayat on blacksmiths in Riau, where the prevalence was 52.38%. These findings highlight a significant occupational health burden among blacksmith workers, with more than half of the workers experiencing LBP.

Bending posture (≥20°) was significantly associated with LBP in 82.9% of blacksmiths (p = 0.034; aOR 3.7; 95% CI = 1,1–12,5). Similar findings were observed in Canadian farmers by Khan, due to the biomechanical similarities with blacksmithing.[11] Blacksmiths were observed assuming a bending posture, such as grinders who smooth or cut metal, use hammers to apply pressure to hot metal, and handle makers working with wood for precise cutting. Static sitting posture (<4 hours/day) was observed in 57.1% of participants and significantly correlated with LBP (p = 0.009; aOR 3,6; 95% CI = 1,4-9,4). Similar to Gupta's research, our findings show that extended sitting among blacksmiths exacerbates LBP risk.[12] Blacksmiths were observed sitting statically, as most of their tasks require long periods at machines or workbenches to handle product details. Static sitting posture increases disc pressure and paraspinal muscle fatigue, even after adjusting for age and rest duration. This finding suggests that static postures independently contribute to LBP risk. None of the respondents stood statically for ≥4 hours and none of the respondents in this study performed hammering at ≥120 times/minute and with a weight of ≥2.5 kg. Therefore, neither variables were further analyzed.

This study found that work duration ≥ 8 hours showed no significant association with LBP because sufficient rest periods between work sessions can help reduce the risk of injury, even with long working hours. In this study, work duration showed no significant

Table 3. Multivariate analysis results

Variables	Low Back Pain		p-value (bivariat)	OR (IK 95%)	p-value (multivariat)	aOR (IK 95%)
	Yes	No				
Bent posture						
≥ 20°	55	32	0,019	3,43	0,034	3,7
< 20°	6	12		(1,18-10,05)		(1,1 s/d 12,5)
Static sitting posture (hours)						
≥ 4	30	15	0,123	1,871	0,009	3,6
< 4	31	29		(0,84-4,17)		(1,4 s/d 9,4)
Rest Time (hours)						
< 0,5	15	3	0,017	4,46	0,006	7,9
≥ 0,5	46	41		(1,2-16,5)		(1,8-35,3)
Age (years)						
≥ 35	52	27	0,005	3,6	0,006	4,6
< 35	9	17		(1,4-9,2)		(1,6-13,6)

association with LBP. The duration of blacksmithing involves repetitive bending and heavy lifting, which can cause mechanical stress on the spine, potentially leading to LBP.[13] In this study, 82,9 % had rest periods ≥ 0.5 hours. Multivariate analysis showed a significant association between rest time and LBP (p = 0.006; aOR 7,9; CI 1,8–35,3). According to Pasal 81 angka 25 Perppu No. 2 Tahun 2022 5 of the Job Creation Law, workers are entitled to at least 30 minutes of rest after 4 hours of work.[14] This finding suggests that a minimum rest period of 15 minutes is necessary to reduce low back pain risk. Inadequate rest leads to muscle fatigue, increased muscle tension, and spasticity, contributing to spinal instability, inflammation, and accelerated disc degeneration.[15]

In this study, the median production quantity was 50 pieces per day, ranging from 5 to 150. However, There was no relationship because adequate rest periods can reduce LBP risk.

The majority of the respondents were aged ≥ 35 years old (75.2%). Multivariate analysis showed a significant association between age and LBP (aOR 4,6; CI 1,6–13,6). Similar to the research by Vasily Shirokov on industrial and agricultural workers in Russia, which states that age is significantly associated with low back pain.[16]

Most workers (71.4%) in this study had a normal BMI. There was no relationship here might be due to the predominance of normal-weight individuals in the sample, reducing the ability to detect differences. Similiarly most workers (91.4%) had only primary or lower secondary education. There was no relationship with LBP because nearly all workers had similar educational levels, and blacksmithing is typically a generational skill learned from a young age, independent of formal education.

In this study, 73.3% of workers had poor exercise habits, defined as physical activity < 2x/week or for less than 30 minutes. There was no relationship with LBP can be attributed to the dynamic nature of blacksmith work, which enhances blood circulation and muscle strength, similar to exercise. Additionally, 66.7% of participants were light smokers, with no significant association between smoking and LBP. The Brinkman Index showed most participants were in the low-risk category (Index < 200), explaining the lack of correlation due to the high percentage of light smokers.

In conclusion, this study demonstrates that, with prevalence of 58.1%, low back pain (LBP) is a common occupational health issue among blacksmiths in Ciwidey Village, Bandung. Significant occupational risk factors identified were forward-bending posture ≥20°, prolonged static sitting posture ≥4 hours per day, rest time of less than 15 minutes per day, and age ≥35 years. The most significant factor was prolonged static sitting (*adjusted odds ratio* [aOR] 4.27; 95% CI 1.62–11.26). Other occupational factors, including standing posture, hammer use, daily work duration, length of employment, and production output, as well as individual characteristics like body mass index, educational level, smoking status, and exercise habits, were not significantly associated with LBP. These results emphasize the significance of primary prevention of musculoskeletal disorders through ergonomic interventions, emphasizing appropriate working posture, frequent active breaks, and routine stretching exercises, especially among older workers, supported by ergonomic training from employers and preventive programs with regular health check-ups promoted by local health authorities. This study should be interpreted in light of several limitations. Data collection coincided with the Eid al-Fitr (Lebaran) holiday period, during which a number of workshops were temporarily closed as workers returned to their hometowns, and several remaining workshops had physically constrained spaces that made it impractical to position the camera at the required 90° lateral angle for APECS video analysis, potentially introducing selection bias toward more accessible workshops. Additionally, a local interpreter was required for some respondents due to regional language barriers, which may have introduced translation bias. Among the 105 workers analyzed, 44 workers (41.9%) did not meet the clinical criteria for LBP. In these workers, the clinical interview revealed no history of lower back pain lasting ≥3 months, VAS scores were below 3, physical examination showed no muscle spasm or tenderness on palpation, and all neurological tests (Laseque, Patrick, and Contrapatrick) were negative. Compared to the 61 workers with LBP (58.1%), those without LBP were more frequently aged under 35 years (38.6% vs. 14.8%), more commonly had rest periods ≥0.5 hours, and less frequently engaged in static sitting ≥4 hours per day a pattern consistent with the multivariate findings and further reinforcing the independent contribution of age, rest duration, and prolonged static sitting to LBP risk in this population.

Conclusion

This study indicates that low back pain (LBP) constitutes a substantial occupational health concern among blacksmith

workers in Ciwidey Village, Bandung, affecting 58.1% of the study population. Occupational factors significantly associated with LBP included forward trunk flexion of ≥20°, prolonged static sitting for at least four hours per day, rest periods shorter than 15 minutes per day, and age ≥35 years, with prolonged static sitting emerging as the strongest predictor of LBP (adjusted odds ratio [aOR] 4.27; 95% CI 1.62–11.26). In contrast, no significant associations were observed for other occupational exposures such as standing posture, hammer use, total daily working hours, length of employment, or production volume, nor for individual characteristics including body mass index, educational attainment, smoking behavior, or exercise habits. These results highlight the critical role of primary prevention strategies in the informal sector, specifically ergonomic interventions aimed at optimizing working posture, that encourage regular active breaks and stretching, optimize working posture, and enhance ergonomic training and preventive health programs for older workers through collaboration between employers and local health authorities.

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