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Factors associated with carpal tunnel syndrome among bag craftsmen in Sidoarjo, Indonesia

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Abstract

Background: Carpal Tunnel Syndrome (CTS) is a wrist disorder caused by compression of the median nerve within the carpal tunnel. It commonly manifests as tingling, numbness, and muscle weakness in the fingers or hand. If left untreated, CTS can lead to more severe physical impairment. Workers engaged in repetitive tasks with awkward postures, such as bag craftsmen at UD Sumber Rejeki, are particularly at risk.
Purpose: To identify risk factors associated with CTS complaints among bag craftsmen in Sidoarjo Regency.
Method: An observational analytic design with a cross-sectional approach was employed. The sample comprised all 43 bag craftsmen. Data were collected through interviews and direct observation using questionnaires, Phalen's Test sheets, the Boston Carpal Tunnel Questionnaire (BCTQ), and wrist posture evaluations with the RULA method. Bivariate analysis was conducted using Chi-square or Fisher's Exact tests, with associations expressed as Odds Ratios (OR) and 95% Confidence Intervals (CI). Results were considered significant at $p<0.05$.
Results: CTS complaints were reported by 26 workers (60.5%). Significant associations were found between gender ($p=0.045$; OR=3.75), length of service ($p=0.009$; OR=6.81), repetitive movements ($p<0.001$; OR=19.60), and awkward hand posture ($p=0.002$; OR=7.11). In contrast, age ($p=0.055$), smoking history ($p=0.206$), and medical history ($p=0.154$) showed no statistically significant associations with CTS complaints.
Conclusion: Gender, duration of employment, repetitive movements, and non-ergonomic postures were significantly associated with CTS complaints among bag craftsmen. The industry is encouraged to implement adequate rest breaks and improve workstation ergonomics to reduce the risk of CTS complaints.

Keywords: Awkward Posture; Bag Craftsmen; Carpal Tunnel Syndrome; Repetitive Movements; Risk Factors.

INTRODUCTION

Carpal Tunnel Syndrome (CTS) is one of the most common hand disorders, arising from compression of the median nerve within the carpal tunnel at the wrist (Djafar & Katuk, 2022). This compression may result from narrowing of the carpal tunnel or swelling of the surrounding synovial tissue, which gradually exerts abnormal pressure on the median nerve (Septiani et al., 2022). Such pressure typically causes tingling, numbness, and muscle weakness in the fingers or hand (Centers for Disease Control and Prevention, 2024). The dominant hand, often used for occupational tasks, is particularly vulnerable. CTS is frequently observed among workers engaged in repetitive movements, forceful gripping, or awkward postures, including dental practitioners (Kostares et al., 2023).

Globally, CTS is a significant occupational health concern. A meta-analysis of 30 studies involving over 5.3 million individuals across 15 countries estimated the prevalence at 14.4%, with women three times

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more likely to be affected than men, particularly between the ages of 40–60 years (Gebrye et al., 2024). National data in Indonesia remain limited. CTS complaints were reported among 34 of 52 Ulos weavers in Medan (Jehaman et al., 2021). CTS is multifactorial; beyond repetitive hand movements and poor ergonomics, risk factors include obesity, diabetes, pregnancy-related hormonal changes, genetic predisposition, anatomical variations, rheumatoid arthritis, and hypothyroidism (Rotaru-Zavaleanu et al., 2024). The National Health Service (2024) further identifies advancing age, use of vibrating tools, family history of CTS, and prior wrist injuries as contributing risks. If untreated, CTS can cause permanent median nerve damage, leading to persistent sensory loss, thenar muscle atrophy, and hand weakness (Padua et al., 2023). Symptoms such as paresthesia and nocturnal pain also impair sleep quality and overall quality of life (Adila et al., 2023).

Evidence from Indonesia highlights CTS prevalence among tailors and garment workers. Studies in Kupang, Denpasar, and North Jakarta found that longer work duration (>4 years) significantly increased CTS risk, with women disproportionately affected (Lalupanda et al., 2020; Paramita et al., 2021; Sitompul, 2022). Yudistira et al. (2022) reported CTS complaints in 31 of 45 sewing operators (66%), largely due to repetitive hand movements exceeding 30 times per minute and non-ergonomic wrist postures. Similarly, Puspita et al. (2022) found 77% of purun craftsmen experienced CTS complaints, with risk heightened by prolonged service (>2 years) and extended working hours (>8 hours/day).

The bag industry, including UD Sumber Rejeki in Sidoarjo, employs 43 workers across cutting, sewing, gluing, packing, and finishing divisions. These tasks involve continuous repetitive movements, often performed under long working hours (7:00 AM–4:00 PM, with overtime until 6:00 PM). Production targets of at least 500 pieces per day, predominantly achieved by female workers, further intensify workload demands. Cutting, sewing, and finishing processes require repetitive flexion, extension, and gripping movements, sometimes exceeding 30–40 repetitions per minute, often in awkward wrist positions. Preliminary interviews with 10 workers revealed hand complaints including pain (40%), tingling (60%), and numbness (30%), most commonly in the palms and forearms, with symptoms worsening at night or during periods of high production demand.

Taken together, prior research and preliminary findings suggest that bag craftsmen are at considerable risk of CTS due to repetitive movements, awkward postures, and extended working hours. This study therefore aimed to analyze the risk factors associated with CTS complaints among bag craftsmen at UD Sumber Rejeki, Tanggulangin District, Sidoarjo Regency.

RESEARCH METHOD

An observational analytic design with a cross-sectional approach was employed to identify risk factors associated with Carpal Tunnel Syndrome (CTS) complaints among bag craftsmen at UD Sumber Rejeki, Kedensari Village, Tanggulangin District, Sidoarjo Regency. Data collection was conducted between January and May 2023. Ethical approval was obtained from the Health Research Ethics Committee, Faculty of Public Health, University of Jember (No. 1099/UN25.1.12/SP/2023) prior to data collection.

The study population comprised all 43 workers. Prior to participation, respondents were informed about the study's objectives, procedures, benefits, and potential risks. Written informed consent was obtained from all volunteers, and confidentiality of identity and data was strictly maintained. A total sampling technique was applied, with all eligible workers included as respondents. Exclusion criteria were workers who were not willing to participate and those who were pregnant at the time of study.

Independent variables included age, gender, smoking history, medical history, length of service, repetitive movements, and awkward hand posture. The dependent variable was CTS complaints. Respondent characteristics were collected through structured interviews. CTS complaints were assessed using the validated Boston Carpal Tunnel Questionnaire (BCTQ) and confirmed with Phalen's test. Repetitive movements were measured by direct observation of movement frequency per minute, while awkward hand postures were evaluated using the Rapid Upper Limb Assessment (RULA) method.

Univariate analysis was performed to describe respondent characteristics using frequency and percentage distributions. Bivariate analysis was

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conducted to examine associations between independent variables and CTS complaints using the Pearson Chi-square test. Assumptions for Chi-square were checked based on expected cell counts; Fisher's Exact test was used as an alternative when more than 20% of cells had expected counts below 5 or when any cell had an expected count below 1. Associations were expressed as Odds Ratios (OR) with 95% Confidence Intervals (CI). Statistical significance was set at $p<0.05$. All data were processed using SPSS software according to standard research procedures.

The variables were categorized based on predefined criteria. CTS-related complaints were classified as positive or negative based on the Boston Carpal Tunnel Questionnaire (BCTQ) score and Phalen's test findings. A BCTQ total score of ≥3 and/or a positive Phalen's test result was categorized as "Yes," whereas a BCTQ score of <3 was categorized as "No." Age was categorized into <30 years, 30–40 years, and >40 years (Paramita et al., 2021). Sex was categorized as male or female. Smoking history was classified as never smoker, light smoker (1–10 cigarettes/day), moderate smoker (11–20 cigarettes/day), or heavy smoker (>20 cigarettes/day) (Alifariki, 2019). Medical history was categorized as no history of illness, diabetes mellitus, kidney disease, injury or fracture, or rheumatoid arthritis (Utamy et al., 2020). Years of service were categorized as <2 years and ≥2 years. Repetitive hand movements were classified as low (<30 movements/minute) or high (≥30 movements/minute) (Mariana et al., 2018). Awkward upper-extremity posture was assessed using the Rapid Upper Limb Assessment (RULA) and categorized according to the final RULA score: 1–2 (negligible risk), 3–4 (low risk), 5–6 (medium risk), and 7 (high risk).

The dependent variable was CTS-related complaints rather than a formal clinical diagnosis. CTS-related complaints were assessed using the Boston Carpal Tunnel Questionnaire (BCTQ), developed by Levine et al. (1993), which comprises an 11-item Symptom Severity Scale (SSS) and an 8-item Functional Status Scale (FSS). Each item is scored from 1 to 5, with higher scores indicating greater symptom severity and functional impairment. The assessment was supported by Phalen's test, performed by maintaining maximum wrist flexion for approximately 60 seconds. A positive test was indicated by pain, numbness, or tingling in the distribution of the median nerve. CTS-related complaints were categorized as "Yes" when the BCTQ score was ≥3 and/or the Phalen's test was positive, and as "No" when the BCTQ score was <3.

Age was categorized as <30 years, 30–40 years, and >40 years (Paramita et al., 2021). Sex was classified as male or female. Smoking history was categorized as never smoker, light smoker (1–10 cigarettes/day), moderate smoker (11–20 cigarettes/day), or heavy smoker (>20 cigarettes/day) (Alifariki, 2019). Medical history was categorized as no history of illness, diabetes mellitus, kidney disease, injury or fracture, or rheumatoid arthritis (Utamy et al., 2020). Years of service were classified as <2 years or ≥2 years. Repetitive hand movements were assessed through direct observation by counting the number of movements per minute and categorized as low (<30 movements/minute) or high (≥30 movements/minute) (Mariana et al., 2018). Upper-extremity work posture was assessed using the Rapid Upper Limb Assessment (RULA) and classified according to the final score as negligible risk (1–2), low risk (3–4), medium risk (5–6), or high risk (7).

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RESEARCH RESULTS

Table 2. Demographic and Occupational Characteristics of Respondents (N=43)

Variables	Results
Age (Mean±SD)(Range)(Year)	**(29.81±6.61)**
< 30	28/65.12
30-40	10/23.25
> 40	5/11.63
Gender (n/%)	
Female	28/65.12
Male	15/34.88
Smoking History (n/%)	
Never-smokers	30/69.77
Light smokers	5/11.63
Moderate smokers	8/18.60
Heavy smokers	0/0.0
Medical History (n/%)	
No	32/74.42
Diabetes *mellitus*	5/11.63
Kidney failure	0/0.0
Injury or fracture	6/13.95
Rheumatoid arthritis	0/0.0
Years of service (n/%)	
< 2 Years	11/25.58
≥ 2 Years	32/74.42
Repetitive Movements (n/%)	
< 30 movements	19/44.19
≥ 30 movements	24/55.81
Awkward Hand Posture (n/%)	
Minimum risk level	6/13.95
Low risk level	28/65.12
Moderate risk level	9/20.93
High risk level	0
Carpal Tunnel Syndrome Complaint (n/%)	
Yes	26/60.47
No	17/39.53

Table 2 summarizes the demographic and occupational characteristics of respondents. The mean age was 29.81 years (SD ± 6.61), with 65.12% under 30 years of age. Females constituted the majority (65.12%). Most participants were classified as never-smokers (69.77%), and 74.42% reported no prior medical history. In terms of work-related factors, 74.42% had more than two years of service, 55.81% demonstrated high levels of repetitive hand movements, and the majority exhibited a low-risk level of awkward hand posture. Overall, 60.47% of respondents reported complaints consistent with Carpal Tunnel Syndrome.

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Table 3. Relationship of Individual and Occupational Factors with CTS Complaint

Variables	*Carpal Tunnel Syndrome* Complaint		*p*-value	(95% CI) OR
	Yes	No		
Age (n/%)				
< 30 years	14/32.56	14/32.56	0.055	4.00
≥ 30 years	12/27.91	3/6.98		
Smoking History (n/%)				
Never-smoker	20/46.51	10/23.26	0.206	2.33
Current smoker	6/13.95	7/16.28		
Gender (n/%)				
Female	20/46.51	8/18.60	0.045	3.75
Male	6/13.95	9/20.93		
Disease History (n/%)				
No	17/39.53	15/34.88	0.154 (Fisher Exact)	3.97
Yes	9/20.93	2/4.65		
Work Period (n/%)				
< 2 Years	3/6.98	8/18.60	0.009	6.81
≥ 2 Years	23/53.49	9/20.93		
Repetitive Movement (n/%)				
< 30 movements	5/11.63	14/32.56	< 0.001	19.60
≥ 30 movements	21/48.84	3/6.98		
Awkward Hand Posture (n/%)				
Minimum and low risk level	18/41.86	16/37.21	0.002	7.11
Moderate risk level	8/18.60	1/2.33		

Table 3 presents the distribution of Carpal Tunnel Syndrome (CTS) complaints across study variables. For age, most affected workers were younger than 30 years (14 individuals, 32.6%), while 12 workers (27.9%) were aged ≥30 years. The odds ratio (OR) was 4.00, indicating that workers aged ≥30 years were four times more likely to report CTS complaints compared to those under 30; however, this association was not statistically significant (p = 0.055). Regarding smoking history, the majority of CTS complaints occurred among never-smokers (20 individuals, 46.5%), compared to 6 smokers (14.0%). The OR of 2.33 suggests that never-smokers had higher odds of reporting CTS complaints than smokers. In terms of gender, female workers accounted for most cases (20 individuals, 46.5%), while male workers represented 6 cases (14.0%). The OR of 3.75 indicates that females were nearly four times more likely to experience CTS complaints compared to males. For medical history, 17 workers without prior illness (39.5%) reported CTS complaints, compared to 9 workers with a medical history (20.9%). Although the OR of 3.97 suggested an increased likelihood among those with a medical history, the relationship was not statistically significant (p = 0.154; Fisher's Exact test).

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Workers with ≥2 years of service reported more CTS complaints (23 individuals; 53.5%) compared to those with <2 years of service (3 individuals; 7.0%). Chi-square analysis confirmed a significant relationship between length of service and CTS complaints (p = 0.009), with an odds ratio (OR) of 6.81, indicating that workers with longer service were nearly seven times more likely to experience CTS complaints. Similarly, workers performing repetitive hand movements ≥30 times per minute reported more CTS complaints (21 individuals; 48.8%) than those with <30 movements per minute (5 individuals; 11.6%). This association was statistically significant (p < 0.001), with an OR of 19.60, suggesting a markedly increased risk. In terms of posture, workers with awkward hand positions at a moderate risk level reported more CTS complaints (8 individuals; 18.6%) compared to those in the minimal-to-low risk category (18 individuals; 41.9%). The relationship was significant (p = 0.002), with an OR of 7.11, indicating that workers with awkward hand postures had over seven times greater odds of experiencing CTS complaints.

DISCUSSION

Age and CTS Complaints

Age was not significantly associated with Carpal Tunnel Syndrome (CTS) complaints among the bag craftsmen at UD Sumber Rejeki, although workers aged ≥30 years had 4.00 times higher odds of experiencing CTS complaints than those aged <30 years (OR = 4.00; p = 0.055). This finding indicates that advancing age may increase susceptibility to CTS, but the effect was not statistically significant in this study. Chronological age refers to age calculated from birth in calendar years, whereas biological age reflects the physiological condition of the body (Setiawan, 2021).

From a physiological perspective, the risk of musculoskeletal problems tends to increase with age because tissue regeneration capacity, muscle strength, tendon elasticity, and the ability of the musculoskeletal system to adapt to repetitive workloads progressively decline. In contrast, younger workers generally retain better muscular strength, endurance, and biomechanical capacity, with muscle strength typically peaking around the age of 30 and remaining relatively stable until approximately 40–50 years before gradually declining (Bouziri et al., 2022; Greggi et al., 2024; Ribeiro et al., 2024). This mechanism may explain why workers aged ≥30 years showed higher odds of CTS in the present study. However, the lack of statistical significance may be related to the relatively young age distribution of the workforce, with 28 workers aged <30 years and 15 workers aged ≥30 years.

Younger workers may also have experienced substantial occupational exposure because they were involved in physically demanding activities, including cutting thick leather and cardboard and performing repetitive hand movements. Thus, their relatively preserved physical capacity may not have protected them from CTS when exposure to repetitive workloads was high. The present finding is consistent with previous study which also found no significant association between age and CTS complaints (Kurniaputri et al., 2022; Putra et al., 2021). However, a study reported a significant relationship among tailors at Busana Mawar Banjarmasin, particularly among workers aged ≥30 years (Noprianti et al., 2020). The difference between these findings may reflect variations in age distribution, occupational tasks, workload intensity, and cumulative ergonomic exposure. Therefore, in this relatively young workforce, occupational exposure may have had a stronger influence on CTS complaints than chronological age alone.

Smoking History and CTS Complaints

Smoking history was not significantly associated with CTS complaints among the bag craftsmen (p = 0.206), although non-smokers had 2.33 times higher odds of experiencing CTS complaints than smokers. This unexpected direction should not be interpreted as indicating that smoking protects against CTS because the finding may have been influenced by the sample distribution, which was dominated by female and non-smoking workers. Cigarettes contain various harmful substances, including carbon monoxide, nicotine, tar, hydrogen cyanide, and benzene, several of which are toxic or carcinogenic (Ministry of Health of the Republic of Indonesia, 2022). Nicotine can reduce blood flow to tissues and contribute to symptoms such as tingling, pain, and numbness, while smoking may also reduce bone mineral content and contribute to structural damage and pain

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(Puspitasari & Yusuf, 2023). Carbon monoxide can further reduce oxygen availability to muscles by binding with oxygen, potentially increasing anaerobic metabolism and lactate accumulation, which may contribute to muscle fatigue and pain (Ningrum & Febriyanto, 2021). These mechanisms provide a plausible explanation for why smoking could contribute to musculoskeletal complaints, although smoking is not necessarily a primary cause of CTS. The present non-significant finding is consistent with studies which found no significant relationship between smoking habits and CTS complaints (Pangestuti & Widajati, 2014; Alhusain et al., 2019). In contrast, it was reported that smoking history significantly increased CTS risk (p = 0.019), with active smokers experiencing higher prevalence and more severe complaints than non-smokers (Riccò & Signorelli, 2017). The discrepancy may be attributable to differences in smoking exposure, sample characteristics, and the relative contribution of occupational ergonomic factors. At UD Sumber Rejeki, the high prevalence of CTS among predominantly non-smoking workers suggests that other factors, particularly repetitive movements and awkward hand postures, may have exerted a stronger influence on CTS complaints. Nevertheless, nicotine-related reductions in blood flow and nutrient delivery, increased blood coagulation, and potential effects on musculoskeletal tissues remain plausible mechanisms through which smoking may contribute to musculoskeletal complaints (Tualeka, 2020; Afro & Paskarini, 2022).

Gender and CTS Complaints

Gender was significantly associated with CTS complaints, with female workers having 3.75 times higher odds of experiencing CTS than male workers (OR = 3.75; p = 0.045). This finding indicates that female bag craftsmen were more vulnerable to CTS, which can be explained by differences in anatomical structure, muscle strength, physiological characteristics, and occupational exposure between women and men. Gender may influence the type and intensity of work performed, resulting in differences in occupational hazard exposure and consequently in workers' health outcomes (Albyn et al., 2022). Women generally have smaller muscle mass, particularly in the upper limbs, and their muscular strength is estimated to be approximately 60% of that of men (Ajhara et al., 2022; Wahyuni, 2021). Lower muscular strength may increase fatigue during tasks involving repetitive or forceful hand movements, while anatomical differences in the carpal tunnel may increase susceptibility to median nerve compression. In addition, hormonal influences, including estrogen-related changes, may affect ligament composition and strength, further contributing to vulnerability to CTS (Ghaisani et al., 2021).

Women also experience physiological conditions such as menstruation, pregnancy, childbirth, and menopause, which may influence musculoskeletal characteristics and susceptibility to fatigue and injury (Ajhara et al., 2022). The finding is therefore consistent with the theoretical mechanism that lower upper-limb strength and anatomical characteristics may reduce women's tolerance to repetitive manual workloads. The faster decline in muscle mass and strength among women may further increase their vulnerability to musculoskeletal disorders (Chidi-Ogbolu & Baar, 2019). In the context of bag production, where workers perform prolonged manual activities such as sewing, cutting, gluing, and assembling, these differences may become particularly relevant. Thus, the significant association observed in this study suggests that female workers may require greater ergonomic protection when performing repetitive and physically demanding hand activities.

Medical History and CTS Complaints

Medical history was not significantly associated with CTS complaints, although workers with a history of illness had 3.97 times higher odds of experiencing CTS than those without a history of illness (OR = 3.97). The elevated odds suggest a possible relationship, but the absence of statistical significance indicates that disease history could not be established as a significant risk factor in this study. Nevertheless, the biological mechanisms associated with specific medical conditions provide a plausible explanation for the observed direction of the association. Diabetes mellitus can affect bones, connective tissue, and muscles, with the hands among the areas most commonly affected (Tan, 2020). Changes associated with diabetes may impair collagen integrity and promote rigidity and thickening of connective tissues,

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including the flexor synovium, while increased collagen deposition may further contribute to carpal tunnel disturbances. Similarly, previous wrist injury or fracture may alter anatomical structures, produce inflammation and edema, and promote scar tissue formation, thereby reducing the available space within the carpal tunnel and increasing pressure on the median nerve (Holbrook et al., 2022; Omole et al., 2023). In the present study, diabetes mellitus and previous injury or fracture were among the medical histories reported by the craftsmen. Elevated glucose concentrations in diabetes may increase collagen cross-linking and stiffness in tendons and other connective tissues, reducing the functional capacity of muscles, ligaments, tendons, and joints and potentially increasing susceptibility to CTS (Prakasa, 2020). Previous wrist injury or fracture may similarly alter bone alignment and narrow the carpal tunnel, increasing median nerve compression (Ghaisani et al., 2021). However, the non-significant result may be related to the distribution of disease history within the sample, as also reported by a research which found no significant association between disease history and CTS complaints, partly because most workers had no history of illness (Asfian et al., 2021). Therefore, although medical history may provide a biological predisposition to CTS, its contribution in this study appears less consistent than the occupational factors involving repetitive movement and awkward posture.

Length of Service and CTS Complaints

Length of service was associated with CTS complaints, with most workers who had been employed for ≥2 years reporting CTS complaints. In this study, 32 workers (74.4%) had worked for ≥2 years, and interviews indicated that many had started working at approximately 19–20 years of age, while others began between 20 and 30 years. Longer employment duration increases cumulative exposure to ergonomic stressors, including repetitive movements, forceful exertion, and non-ergonomic postures. Such repeated exposure can progressively produce microtrauma in the tendons and surrounding tissues within the carpal tunnel, increasing tissue irritation and pressure on the median nerve. Consequently, the longer workers perform repetitive hand-intensive tasks, the greater the cumulative biomechanical burden to which the wrist is exposed. This mechanism is particularly relevant at UD Sumber Rejeki because workers may repeatedly perform sewing, cutting, gluing, assembling, and other manual activities throughout their employment. The present finding is consistent with previous studies showing that longer work duration is associated with increased CTS risk (Paramita et al., 2021; Lalupanda et al., 2020; Hartanti et al., 2018). It is also supported by evidence that high levels of repetitive work, rapid work pace, and combined physical exposures are associated with CTS incidence (Gerger et al., 2024). Therefore, length of service may function as an indicator of cumulative occupational exposure rather than an independent biological cause of CTS. The longer a worker remains exposed to repetitive and non-neutral hand activities, the greater the opportunity for repeated mechanical stress to accumulate and contribute to median nerve compression.

Repetitive Movements and CTS Complaints

Repetitive movement demonstrated the strongest association with CTS complaints in this study. Workers who performed ≥30 movements per minute had 19.60 times higher odds of experiencing CTS than those performing <30 movements per minute (OR = 19.60; $p < 0.001$). Repetitive movement refers to the average number of body-part movements performed continuously within a unit of time (Sari et al., 2022), and high-frequency repetition places repeated biomechanical stress on muscles, tendons, and nerves. When such movements are sustained, the repeated loading can cause microtrauma and inflammation of the tendons and surrounding tissues, increasing pressure within the carpal tunnel and subsequently compressing the median nerve (Gerger et al., 2024). This mechanism closely corresponds with the work activities observed at UD Sumber Rejeki. Sewing and finishing workers repeatedly move their hands while guiding and assembling bag materials, cutting workers repeatedly operate cutters or scissors, and gluing workers repeatedly apply adhesive and press cardboard onto bag materials. The gluing section demonstrated the highest frequency of repetitive movement, reaching ≥30 movements per minute, because workers need to accelerate the process to prevent delays associated with adhesive drying and subsequent production

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stages. Such production pressure can reduce opportunities for recovery and increase cumulative hand fatigue. The magnitude of the association in this study is consistent with previous research demonstrating significant relationships between repetitive movement and CTS incidence (Utami et al., 2021; Noprianti et al., 2020; Tjendra et al., 2022). Thus, the OR of 19.60 indicates that repetitive movement was a particularly important occupational factor for CTS complaints in this workforce, with high movement frequency providing a plausible mechanical pathway through which repeated loading, tissue irritation, and median nerve compression may occur.

Awkward Hand Posture and CTS Complaints

Awkward hand posture was significantly associated with CTS complaints, with workers classified as having moderate-risk postures showing 7.11 times higher odds of experiencing CTS than workers with minimal or low-risk postures (OR = 7.11; p = 0.002). Although all workers adopted some degree of awkward hand posture, 28 workers (65.12%) were classified at a low-risk level. Awkward hand posture involves maintaining the wrist in non-neutral positions during activities such as sewing, cutting, pattern making, gluing, and packing. These positions increase mechanical stress on muscles, joints, and ligaments and can reduce comfort during work, particularly when combined with high job demands and non-ergonomic tools or workstations (Pratiwi et al., 2022; Gerger et al., 2024).

From a CTS perspective, wrist flexion, extension, and radial or ulnar deviation can increase pressure within the carpal tunnel and contribute to compression of the median nerve. Repeated exposure to these positions may therefore produce cumulative tissue stress and increase the likelihood of CTS complaints. This mechanism is evident in the finishing section, where workers repeatedly sew, assemble bag components, and install magnets and rivets while frequently maintaining non-neutral wrist positions. The significant association observed in this study is consistent with previous research demonstrating relationships between non-neutral working postures and CTS incidence (Yudistira et al., 2022; Wulandari et al., 2020; Selviyati et al., 2016). Therefore, the OR of 7.11 suggests that awkward posture represents an important occupational contributor to CTS complaints at UD Sumber Rejeki, particularly when non-neutral wrist positions are repeatedly maintained during manual production tasks. The findings support the need to reduce prolonged wrist flexion, extension, and deviation and to improve the ergonomic design of workstations and tools.

Limitations

This study has several important limitations that should be considered when interpreting the findings. First, the research involved only 43 respondents from a single bag manufacturing industry, which limits the generalizability of the results to a broader worker population. Second, the study employed a cross-sectional design, meaning that risk factors and Carpal Tunnel Syndrome (CTS) complaints were measured simultaneously. Consequently, the observed associations cannot be interpreted as causal relationships. Third, the analysis was restricted to bivariate methods, which did not account for potential confounding variables such as age, gender, years of service, and other individual characteristics that may influence the relationship between occupational factors and CTS complaints. Therefore, future research is recommended to involve a larger sample size, include multiple study sites, and employ multivariate analysis to control for confounding factors and provide more accurate estimates of the associations.

CONCLUSION

The results showed that work period, repetitive movements, and awkward hand postures were significantly associated with Carpal Tunnel Syndrome (CTS) complaints. Workers with ≥2 years of service had 6.81 times higher odds of experiencing CTS, those performing repetitive movements ≥30 times per minute had 19.60 times higher odds, and those with moderate-risk awkward hand postures had 7.11 times higher odds compared to reference groups. In contrast, age, smoking history, and disease history did not show statistically significant associations with CTS, although workers aged ≥30 years, smokers, and those with prior illnesses tended to have higher odds compared to their counterparts. These findings highlight that ergonomic factors—particularly repetitive movements, length of service, and awkward

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wrist postures—are strongly linked to CTS complaints among bag craftsmen. Preventive measures should therefore prioritize ergonomic improvements in workstations, scheduled rest breaks with stretching, worker education on CTS prevention, and regular health monitoring. Future studies are recommended to involve larger sample sizes, multiple research sites, and additional variables such as body mass index, genetic predisposition, vibration exposure, mechanical pressure, and workplace temperature to provide a more comprehensive understanding of CTS risk factors.

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