

The Correlation of Repetitive Movements, Wrist Postures, and Work Duration with Carpal Tunnel Syndrome Complaints among Hand-Drawn Batik Workers

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ABSTRACT

Background: Carpal Tunnel Syndrome (CTS) is a median nerve entrapment disorder that may be influenced by occupational biomechanical exposure. Hand-drawn batik workers perform precise, repetitive hand movements and may sustain non-neutral wrist postures for prolonged periods. **Method:** This analytical quantitative study used a cross-sectional design involving 96 female hand-drawn batik workers in Giriloyo, Bantul, Special Region of Yogyakarta. Data were collected using the Boston Carpal Tunnel Questionnaire (BCTQ), direct observation of repetitive movement and wrist posture, and respondent characteristics. Associations were tested using the Chi-square test. **Results:** Repetitive movement was significantly associated with CTS complaints ($p < 0.001$; OR 6.00, 95% CI 2.27–15.86). Wrist posture was also significantly associated with CTS complaints ($p = 0.001$), with severe complaints most frequent among workers with non-neutral posture (76.7%). Work duration was significantly associated with CTS complaints ($p = 0.001$; OR 4.48, 95% CI 1.85–10.81), with severe complaints most frequent among workers with long daily work duration (71.7%). **Conclusion:** Repetitive movement, wrist posture, and work duration were significantly associated with CTS complaints in this group. Ergonomic redesign, neutral wrist positioning, and structured rest periods, while recognizing that the cross-sectional design does not establish causality



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Introduction

Carpal Tunnel Syndrome (CTS) is a compressive neuropathy of the median nerve at the wrist and is one of the most common entrapment neuropathies of the upper limb. A recent systematic review and meta-analysis estimated a pooled global prevalence of approximately 14.4%, although estimates vary substantially across populations and diagnostic definitions (1). In occupational health, CTS is particularly relevant because physical exposures involving high repetition, force intensity, and combined biomechanical loading have been associated with increased incidence (2,3).

Evidence from prospective occupational studies supports the role of repetitive hand activity and overall biomechanical load. Hassan et al. reported high-certainty associations between CTS



and high repetition, force intensity, exposures above the ACGIH hand-activity level, and high Strain Index values (2). A systematic review of prospective studies likewise found that high repetition, movement velocity, and combinations of physical exposures were associated with incident CTS, although the quality and consistency of evidence varied between studies (3). More recent cohort evidence from Denmark and Sweden further indicates that occupational hand exposures and upper-extremity biomechanical loading are relevant to CTS risk (7, 8).

Hand-drawn batik is a manual craft activity requiring repeated, precise movements of the hand and wrist while controlling a canting over fabric. In such work, repetitive movement can coexist with sustained or repeated wrist deviation and prolonged daily exposure. This combination is important because occupational CTS is better understood as the result of interacting biomechanical exposures rather than a single isolated movement (2–4). The occupational context also matters for prevention: interventions should target the exposure itself through task design, posture, work-rest organization, and worker education rather than relying only on treatment after symptoms become severe (13).

The available manuscript reports significant associations between repetitive movement, wrist posture, and work duration with CTS complaints among 96 hand-drawn batik workers in Giriloyo. However, previous evidence in occupational populations is heterogeneous, and the specific combination of these exposures in traditional batik work remains under-described. The present study therefore aimed to analyze the relationship of repetitive movement, wrist posture, and daily work duration with CTS complaints among hand-drawn batik workers in Giriloyo, Bantul, Special Region of Yogyakarta. The findings are intended to support practical occupational-health recommendations for an informal craft workplace.

Materials and Method

This study used an analytical quantitative approach with a cross-sectional design. The research was conducted in the hand-drawn batik craft center of Giriloyo, Imogiri, Bantul, Special Region of Yogyakarta. The final sample comprised 96 active female hand-drawn batik workers who met the study criteria. The manuscript states that the respondents were selected using total sampling/purposive sampling according to the study criteria; this wording is retained because the source manuscript does not provide enough information to resolve the sampling terminology further.

The independent variables were repetitive movement, wrist posture, and daily work duration, while the dependent variable was CTS complaints. Data collection used the Boston Carpal Tunnel Questionnaire (BCTQ), direct observation of work posture and repetitive movement, and a respondent identity form. BCTQ is a symptom/function questionnaire; because the present study is based on complaints rather than electrodiagnostic confirmation, the outcome should be interpreted as CTS complaints rather than clinically confirmed CTS. This distinction is consistent with recent literature emphasizing variability in diagnostic criteria and the need to distinguish screening from definitive diagnosis (14–17).

Univariate analysis was used to describe respondent characteristics, and bivariate analysis used the Chi-square test to assess associations between the independent variables and CTS complaints. The manuscript reports ethical approval from the Health Research Ethics Committee of Universitas Muhammadiyah Purwokerto, registration number KEPK/UMP/22/V/2026. Because the study was cross-sectional, associations should not be interpreted as proof of temporal causality.

Results

The study included 96 female hand-drawn batik workers. Most respondents were in the early-elderly age group (30; 31%), followed by late adulthood (24; 25%). Regarding work tenure, 58 respondents (60%) had worked for 6–15 years. The detailed distribution is presented in Table 1. Age Distribution: The cohort spans across various age groups, with the largest proportion falling into the early elderly category (31%, n=30), followed by late adulthood (25%, n=24). Combined, workers aged late adulthood and older represent the vast majority (84%) of the workforce, indicating an aging demographic in traditional batik crafting. Work Tenure: The vast majority of workers (60%, n=58) have been engaged in batik work for 6–15 years, while an additional 39% (n=37) have over 15 years of experience. Only a tiny fraction (1%, n=1) has worked for less than

6 years, reflecting high occupational stability and prolonged cumulative exposure to the physical demands of the trade.

Table 1. Characteristics of respondents

Characteristic	Frequency (n)	Percentage (%)
Early adulthood	15	16
Late adulthood	24	25
Early elderly	30	31
Late elderly	19	20
Oldest-old	8	8
Female	96	100
<6 years work tenure	1	1
6–15 years work tenure	58	60
16–25 years work tenure	23	24
>25 years work tenure	14	15
Total	96	100

Table 2 summarizes the association between repetitive movement, wrist posture, and work duration with CTS complaints. Severe complaints were most frequent among workers with high repetitive movement (70.6%), non-neutral wrist posture (76.7%), and long work duration (71.7%). All three variables showed statistically significant associations with CTS complaints.

Table 2. Association between repetitive movement, wrist posture, work duration, and CTS complaints

Variable	Category	Severe n (%)	Mild n (%)	Total n	p-value	OR (95% CI)
Repetitive movement	High	48 (70.6)	20 (29.4)	68	<0.001	6.00 (2.27–15.86)
	Low	8 (28.6)	20 (71.4)	28		
Wrist posture	Non-neutral	23 (76.7)	7 (23.3)	30	0.001	—
	Less neutral	24 (66.7)	12 (33.3)	36		
	Neutral	9 (30.0)	21 (70.0)	30		
Work duration	Long	43 (71.7)	17 (28.3)	60	0.001	4.48 (1.85–10.81)
	Normal	13 (36.1)	23 (63.9)	36		

Repetitive Movement: High repetitive hand movement demonstrates a highly significant association with severe CTS complaints ($p < 0.001$). Workers with high repetition experienced a 70.6% rate of severe complaints compared to 28.6% in the low-repetition group. The odds ratio (OR = 6.00, 95% CI: 2.27–15.86) indicates that workers exposed to high repetitive movements are 6 times more likely to report severe CTS complaints than those with low repetition. **Wrist Posture:** Non-neutral wrist posture shows a significant relationship with CTS severity ($p = 0.001$). The prevalence of severe CTS complaints follows a clear gradient corresponding to posture deviation: 76.7% in non-neutral posture, 66.7% in less neutral posture, and only 30.0% in neutral posture. **Work Duration:** Daily work duration is significantly associated with severe CTS complaints ($p = 0.001$). Among workers with long daily hours, 71.7% reported severe complaints compared to 36.1% among those with normal duration. Workers with long work hours have 4.48 times higher odds (OR = 4.48, 95% CI: 1.85–10.81) of experiencing severe CTS complaints.

Discussion

The main finding is that high repetitive movement was strongly associated with more severe CTS complaints ($p < 0.001$; OR 6.00, 95% CI 2.27–15.86). This finding is consistent with systematic-review evidence showing that high repetition is an occupational exposure associated with incident CTS. Hassan et al. found a high-certainty association between high repetition and CTS incidence (HR 1.87, 95% CI 1.42–2.46), while Gerger et al. similarly identified high repetition and movement velocity as relevant physical work exposures (2, 3). The large effect estimate in the present study should nevertheless be interpreted cautiously because it comes from a cross-sectional sample and uses CTS complaints rather than electro diagnostically confirmed CTS.

The mechanism is biologically plausible. Repeated hand activity may increase mechanical loading around the carpal tunnel, particularly when repetition is accompanied by forceful exertion or limited recovery. Recent occupational reviews emphasize that CTS risk is often generated by combinations of physical exposures rather than one movement in isolation (4). A prospective

validation study of the Revised Strain Index also found increasing CTS risk at higher levels of cumulative hand/wrist exposure, supporting the concept of dose-related biomechanical loading (6). The present batik activity likely represents a task in which repetition and sustained precision demands occur together.

Wrist posture was significantly associated with CTS complaints ($p=0.001$). Severe complaints were reported by 76.7% of workers with non-neutral posture, compared with 30.0% among workers with neutral posture. This pattern is consistent with occupational evidence that non-neutral wrist positioning can contribute to median-nerve compression and increased carpal-tunnel loading. The 2024 occupational scoping review identifies abnormal wrist posture, sustained wrist flexion, repetitive hand/wrist movement, forceful gripping, and insufficient rest as relevant occupational or ergonomic factors (4). The large Swedish construction-worker cohort also found associations between CTS surgery and repetitive wrist flexion/extension and full wrist extension (8). Although those workers and tasks differ substantially from batik workers, the biomechanical principle is comparable.

Work duration was also significantly associated with CTS complaints ($p=0.001$; OR 4.48, 95% CI 1.85–10.81). Severe complaints occurred in 71.7% of workers classified as having long daily work duration, compared with 36.1% among those with normal duration. The finding supports the broader occupational literature in which cumulative exposure and combinations of physical demands are relevant to CTS development (2, 3, 5, 7). However, work duration should not be interpreted as an independent causal factor without considering what occurs during that time. Long exposure becomes more relevant when it represents prolonged repetition, force, non-neutral posture, or insufficient recovery.

Taken together, the three associations suggest an exposure pattern rather than three unrelated predictors. A worker who repeatedly manipulates the canting, maintains a non-neutral wrist, and works for long periods may receive a greater cumulative biomechanical load. This interpretation is consistent with occupational CTS literature emphasizing high Strain Index values and combined physical exposures (2, 3, 6). The practical implication is that prevention should address the work system: reduce unnecessary repetition, facilitate a more neutral wrist position, introduce realistic recovery periods, and provide ergonomic training.

The use of BCTQ in this study is appropriate for assessing symptoms and functional impact, but it does not by itself establish a definitive clinical diagnosis. Recent diagnostic systematic reviews show that no single clinical or sensory-motor test is sufficient in all settings and that diagnostic criteria vary across studies (14–17). Therefore, the present results should be described as associations with CTS complaints, not as proof of clinically confirmed CTS. This distinction is important when comparing the present study with cohort studies that use electrodiagnostic or surgical outcomes (2,7,8).

The study has strengths, including direct observation of work exposures and inclusion of a specific traditional craft workforce that is rarely represented in international occupational cohorts. It also evaluates three interacting ergonomic dimensions in the same worker group. The principal limitation is the cross-sectional design, which prevents determination of whether the exposures preceded the symptoms. In addition, the sample was limited to female workers in one batik center, so generalizability to male workers, other batik centers, or other manual occupations is uncertain. The outcome was based on complaints rather than clinical confirmation, and potential confounding factors were not reported in the source manuscript. These limitations should be considered before translating the effect sizes into causal risk estimates.

For prevention, the most defensible immediate recommendations are low-cost ergonomic measures: maintain the wrist as close to neutral as practical, optimize the height and position of the work surface, alternate tasks when feasible, and schedule periodic recovery pauses. Exercise or stretching can be considered as an adjunct rather than a substitute for exposure reduction. Evidence syntheses indicate that conservative and physical-therapy approaches can improve symptoms in some patients, but these clinical interventions do not replace primary prevention of occupational exposure (21–25). The strength of this study lies in its focus on an underrepresented population in occupational health literature female hand-drawn batik workers in the informal sector—alongside the use of direct observation to evaluate three interacting ergonomic risk factors simultaneously. Conversely, its main limitations include the cross-sectional design, which precludes establishing temporal causality, reliance on the Boston Carpal Tunnel Questionnaire (BCTQ) measuring self-reported complaints rather than electro diagnostically confirmed clinical

diagnoses, a sample restricted to female workers at a single craft center, and the absence of reporting on potential confounding variables.

Conclusion

Among the 96 hand-drawn batik workers studied in Giriloyo, repetitive movement, wrist posture, and work duration were significantly associated with CTS complaints. High repetitive movement showed an OR of 6.00 (95% CI 2.27–15.86), while long work duration showed an OR of 4.48 (95% CI 1.85–10.81). Wrist posture was also significantly associated with complaints ($p=0.001$), with the highest proportion of severe complaints among workers with non-neutral posture. Because the study was cross-sectional and relied on symptom-based assessment, the findings indicate association rather than causation or confirmed clinical CTS. Preventive efforts should prioritize ergonomic adjustment, neutral wrist positioning, task variation, and adequate recovery periods, with further prospective studies recommended to evaluate causal relationships and intervention effectiveness.

Declaration

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Conflicts of Interest: The authors declare no conflict of interest.

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