

## Association Between Repetitive Movement Exposure and Carpal Tunnel Syndrome Symptoms Among Office Workers: A Cross-Sectional Study

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### ABSTRACTS

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
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| <b>Purpose</b>               | Carpal Tunnel Syndrome (CTS) symptoms are an occupational health concern among office workers who perform repetitive hand and wrist movements during computer-based activities. This study aimed to examine the association between repetitive movement exposure and CTS symptoms among office workers at PT Karya Bintang Mandiri.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Materials and Methods</b> | This analytical cross-sectional study involved 164 office workers recruited using purposive sampling. Repetitive movement exposure was assessed using the Occupational Repetitive Actions (OCRA) Checklist, while CTS symptoms were evaluated using the Boston Carpal Tunnel Questionnaire (BCTQ). Descriptive statistics and the Pearson Chi-Square test were used to examine the association between repetitive movement exposure and CTS symptoms.                                                                                                                                                                                                                                                                                                                               |
| <b>Result</b>                | Moderate repetitive movement exposure was observed in 83 participants (50.6%), followed by high exposure in 42 (25.6%) and low exposure in 39 (23.8%). Regarding CTS symptoms, 62 participants (37.8%) reported no symptoms, 68 (41.5%) reported mild symptoms, 32 (19.5%) reported moderate symptoms, and 2 (1.2%) reported severe symptoms. The Pearson Chi-Square test indicated a significant association between repetitive movement exposure and CTS symptom categories, $\chi^2(6) = 35.06$ , $p < 0.001$ . In a supplementary dichotomized analysis, the prevalence of moderate-to-severe CTS symptoms was 47.6% (20/42) among workers with high exposure and 11.5% (14/122) among workers with low-to-moderate exposure (prevalence ratio [PR] = 4.15; 95% CI: 2.31–7.46). |
| <b>Conclusion</b>            | Repetitive movement exposure was associated with CTS symptom categories among office workers at PT Karya Bintang Mandiri. These findings support the importance of ergonomic risk assessment and preventive measures in office environments. Further studies using longitudinal designs and clinical diagnostic assessments are warranted.                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Keywords</b>              | Carpal tunnel syndrome; Ergonomics; Office workers; Repetitive movement; Cross-sectional study.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

### INTRODUCTION

Carpal Tunnel Syndrome (CTS) is a work-related musculoskeletal disorder characterized by compression of the median nerve within the carpal tunnel, which may cause pain, numbness, tingling, weakness, and impaired hand function (Aboonq, 2015). Occupational factors associated

with CTS include repetitive hand and wrist movements, forceful exertion, awkward wrist postures, and prolonged exposure to repetitive tasks (Aprilia et al., 2021; Aswin et al., 2022; Tarwaka, 2020). Although office work generally involves lower physical demands than manual occupations, prolonged keyboard typing, mouse operation, and sustained wrist positions may expose office workers to repetitive biomechanical loading of the upper extremities (Lietz et al., 2021; Borhany et al., 2022; Mansoor et al., 2021). These activities may contribute to increased pressure within the carpal tunnel and irritation of the median nerve, particularly when repetitive movements are performed with insufficient recovery time (Colombini & Occhipinti, 2018).

Previous research has examined repetitive movements and CTS across various occupational groups, including industrial, manufacturing, agricultural, healthcare, and computer-based workers (Aprilia et al., 2021; Aswin et al., 2022; Rahmawati & Dwiastuti, 2023; Rosiyana & Koesyanto, 2023; Feng et al., 2021; Ghaisani et al., 2021). Studies involving computer users have also identified repetitive tasks, prolonged computer use, and ergonomic conditions as factors associated with upper-extremity musculoskeletal symptoms (Agarwal et al., 2021; Ceylan et al., 2021; Zhang et al., 2022; Yang et al., 2022; Alabdulwahab et al., 2023). These findings indicate that repetitive occupational exposure is relevant to office workers as well as workers in more physically demanding occupations. Nevertheless, the distribution of CTS symptom severity across different levels of repetitive movement exposure among office workers in Indonesia warrants further investigation.

An important issue is whether higher levels of repetitive movement exposure are associated with a different distribution of CTS symptom severity, rather than merely the presence or absence of symptoms. Examining exposure and symptoms across ordered categories may provide more detailed evidence regarding this association. The Occupational Repetitive Actions (OCRA) Checklist assesses repetitive upper-limb exposure through factors including movement frequency, force, posture, and recovery time, while the Boston Carpal Tunnel Questionnaire (BCTQ) assesses CTS-related symptoms and functional limitations. These instruments can therefore support a structured assessment of occupational exposure and symptom severity without, by themselves, establishing a causal relationship. Preliminary observations at PT Karya Bintang Mandiri indicated that office employees generally performed computer-based administrative work for approximately eight hours per day, and some reported wrist pain, tingling, numbness, muscle stiffness, or reduced hand strength after prolonged computer use. This workplace context provides a practical basis for examining how repetitive movement exposure categories are associated with CTS symptom categories among Indonesian office workers.

Therefore, this study aimed to determine the association between repetitive movement exposure and CTS symptoms among office workers at PT Karya Bintang Mandiri, Indonesia. It was hypothesized that repetitive movement exposure would be significantly associated with CTS symptom categories, with workers in higher exposure categories expected to show a greater proportion of moderate-to-severe symptoms than those in lower exposure categories.

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## METHODS

### *Study Participants*

A total of 164 respondents who met the eligibility criteria were included using purposive sampling. The inclusion criteria were office workers who routinely performed computer-based administrative tasks, had been employed for at least one year, were willing to participate, and provided written informed consent. Workers with a history of wrist fracture, previous wrist

surgery, congenital upper-extremity abnormalities, or diagnosed neurological disorders affecting upper-limb function were excluded.

### Study Organization

This analytical observational study employed a quantitative cross-sectional design to examine the association between repetitive movement exposure and Carpal Tunnel Syndrome (CTS) symptoms among office workers at PT Karya Bintang Mandiri, Indonesia. The study was conducted at PT Karya Bintang Mandiri, Indonesia. Ethical approval was obtained from the Health Research Ethics Committee of Universitas Jember (Approval No. 3610/UN25.8/KEPK/DL/2025) before data collection. All participants provided written informed consent, and confidentiality and anonymity were maintained throughout the study. Demographic characteristics, including sex, age, years of employment, daily working duration, and body mass index (BMI), were collected using a structured questionnaire. Repetitive movement exposure was assessed using the Occupational Repetitive Actions (OCRA) Checklist, which evaluates repetitive upper-limb activities based on movement frequency, force, posture, recovery time, and additional ergonomic risk factors (Colombini & Occhipinti, 2018). CTS symptoms were assessed using the Boston Carpal Tunnel Questionnaire (BCTQ), which comprises two separate scales: the Symptom Severity Scale (SSS), which assesses symptom severity, and the Functional Status Scale (FSS), which assesses difficulties in performing daily activities.

### Statistical Analysis

Data were coded and analyzed using IBM SPSS Statistics version 29.0. Descriptive statistics were used to summarize participants' characteristics and study variables. Categorical variables were presented as frequencies and percentages. The association between repetitive movement exposure and CTS symptoms was initially analyzed using the Chi-square test. A p-value of less than 0.05 was considered statistically significant.

## RESULT

A total of 164 office workers from PT Karya Bintang Mandiri participated in this study. Respondents' characteristics included sex, age, years of employment, daily working duration, body mass index (BMI), repetitive movement exposure, and Carpal Tunnel Syndrome (CTS) symptoms.

**Table 1.** Characteristics of the Respondents (n = 164)

| Variable               | Category    | N   | %     |
|------------------------|-------------|-----|-------|
| Sex                    | Male        | 80  | 48.8  |
|                        | Female      | 84  | 51.2  |
| Age                    | 20–30 years | 116 | 70.7  |
|                        | 31–45 years | 47  | 28.7  |
|                        | >45 years   | 1   | 0.6   |
| Years of Employment    | ≤2 years    | 44  | 26.8  |
|                        | >2 years    | 120 | 73.2  |
| Daily Working Duration | ≤8 hours    | 94  | 57.3  |
|                        | >8 hours    | 70  | 42.7  |
| Body Mass Index        | Underweight | 0   | 0.0   |
|                        | Normal      | 164 | 100.0 |
|                        | Overweight  | 0   | 0.0   |
|                        | Obesity I   | 0   | 0.0   |

The majority of respondents were female (51.2%). Most respondents were aged 20–30 years (70.7%), had worked for more than two years (73.2%), and worked ≤8 hours per day (57.3%). Body mass index (BMI) was recorded as a categorical variable in the study dataset and reported according to the categories presented in the results. The available manuscript did not document the specific measurement procedures, the equipment used to obtain body weight and height, or the reference criteria applied for BMI classification.

**Table 2.** Distribution of Repetitive Movement Exposure

| Repetitive Movement Level | N   | %     |
|---------------------------|-----|-------|
| Low (16–28)               | 39  | 23.8  |
| Moderate (29–44)          | 83  | 50.6  |
| High (45–64)              | 42  | 25.6  |
| Total                     | 164 | 100.0 |

Most respondents were categorized as having moderate repetitive movement exposure (50.6%), followed by high exposure (25.6%) and low exposure (23.8%).

**Table 3.** Distribution of Carpal Tunnel Syndrome Symptoms

| CTS Symptoms | N   | %     |
|--------------|-----|-------|
| No symptoms  | 62  | 37.8  |
| Mild         | 68  | 41.5  |
| Moderate     | 32  | 19.5  |
| Severe       | 2   | 1.2   |
| Total        | 164 | 100.0 |

Most respondents experienced mild CTS symptoms (41.5%), whereas only 1.2% reported severe symptoms.

**Table 4.** Association Between Repetitive Movements and CTS Symptoms

| Repetitive Movement | No Symptoms<br>n (%) | Mild<br>n (%) | Moderate<br>n (%) | Severe<br>n (%) | Total | p-value |
|---------------------|----------------------|---------------|-------------------|-----------------|-------|---------|
| Low                 | 21 (53.8)            | 11 (28.2)     | 7 (17.9)          | 0 (0.0)         | 39    |         |
| Moderate            | 35 (42.2)            | 41 (49.4)     | 7 (8.4)           | 0 (0.0)         | 83    |         |
| High                | 6 (14.3)             | 16 (38.1)     | 18 (42.9)         | 2 (4.8)         | 42    |         |
| Total               | 62 (37.8)            | 68 (41.5)     | 32 (19.5)         | 2 (1.2)         | 164   | 0.001   |

As shown in Table 4, the proportion of respondents reporting moderate-to-severe CTS symptoms was 17.9% in the low-exposure group, 8.4% in the moderate-exposure group, and 47.7% in the high-exposure group.

## DISCUSSION

In the present study, 62.2% of respondents reported mild-to-severe symptoms suggestive of carpal tunnel syndrome (CTS), whereas 37.8% reported no symptoms. This proportion provides an indication of the symptom burden among the participating office workers; however, it should not be interpreted as the prevalence of clinically confirmed CTS because the assessment was based on the Boston Carpal Tunnel Questionnaire (BCTQ) without electrodiagnostic confirmation. Feng et al. (2021) reported wrist numbness, wrist pain, hand numbness, and hand pain in 22.4%, 22.5%, 18.0%, and 15.3% of office workers, respectively, and reported clinically identified CTS in 9.6% of participants. Dastgeer et al. (2025) reported CTS in 45.3% of office workers who used keyboards for more than six hours per day, with moderate-to-severe symptoms reported in 41.3%. Although the proportion of respondents reporting symptoms in the present study was numerically higher than the estimates reported in these studies, direct comparison requires caution because the outcome definitions, assessment methods, and participant characteristics may differ. In particular, the present

study used symptom categories derived from the BCTQ, whereas the comparison studies may have applied different symptom definitions or diagnostic procedures. Differences in working conditions, exposure duration, ergonomic practices, and the criteria used to classify symptoms may also contribute to variation across studies. Therefore, these findings should be interpreted as evidence of a substantial burden of CTS-like symptoms in this particular workplace rather than as evidence of a higher prevalence of clinically confirmed CTS.

The association observed between repetitive movement exposure and CTS-like symptoms is biologically plausible, even though office work generally involves lower physical force than many manufacturing and manual occupations. Repetitive keyboard and mouse use may involve frequent wrist and finger movements, sustained or non-neutral wrist postures, and insufficient recovery periods. When these exposures occur repeatedly over a working day, they may contribute to discomfort and symptoms in the hand and wrist. However, repetitive movement should not be considered an isolated determinant of CTS-like symptoms. Individual susceptibility, total exposure duration, workstation configuration, non-occupational hand activities, and underlying health conditions may also influence symptom reporting. Moreover, the evidence linking computer use specifically to CTS is not conclusive. Palmer et al. (2007) found insufficient evidence to establish a clear association between computer work and CTS. This contrasts with studies reporting occupational associations between repetitive hand-intensive activities and CTS-related outcomes. The apparent disagreement may partly reflect differences in exposure definitions, study designs, diagnostic criteria, and the distinction between musculoskeletal symptoms and clinically confirmed CTS. Accordingly, the findings of the present study support the importance of assessing repetitive movement as a potential ergonomic risk factor but do not establish that computer use directly causes CTS.

The distribution of symptoms across the repetitive movement exposure categories was not consistently monotonic. The proportion of respondents reporting moderate-to-severe symptoms was 17.9% in the low-exposure group, 8.4% in the moderate-exposure group, and 47.7% in the high-exposure group. Although the high-exposure group had the largest proportion of moderate-to-severe symptoms, the proportion in the moderate-exposure group was lower than that in the low-exposure group. Thus, the findings do not demonstrate a uniform dose-response relationship across all three exposure categories. Several explanations may be considered, although they cannot be confirmed from the available data. First, categorizing OCRA Checklist scores may have resulted in exposure misclassification, particularly if the selected cut-off points did not accurately distinguish the levels of ergonomic risk in this workforce. Second, unmeasured differences in work tasks, individual susceptibility, recovery time, or non-occupational activities may have contributed to the observed distribution. Third, a healthy worker effect may have influenced the results if workers experiencing more severe symptoms had moved to less demanding tasks or left employment; however, employment history and symptom-related job changes were not assessed sufficiently to establish this explanation. The small number of respondents in the severe-symptom category ( $n = 2$ ) also limits interpretation of the distribution at the highest symptom level. Furthermore, the observed association should be interpreted in light of the assumptions of the statistical test used, particularly because some cells in the contingency table had small expected frequencies. The results therefore warrant cautious interpretation and should not be taken as evidence of a consistent dose-response relationship without further analysis using appropriate statistical methods for ordinal variables and validated exposure categories.

This study has several limitations. First, its cross-sectional design prevents the establishment of temporal relationships and causal inferences between repetitive movement exposure and CTS-

like symptoms. Second, symptoms were assessed using the BCTQ without electrodiagnostic confirmation; therefore, the outcome should be referred to consistently as CTS-like symptoms or symptoms suggestive of CTS rather than clinically confirmed CTS. Third, purposive sampling at a single company may have introduced selection bias and limits the generalizability of the findings to office workers in other organizations or occupational settings. Fourth, the analysis did not adequately control for potential confounding variables, including age, sex, employment duration, daily working hours, non-occupational repetitive activities such as mobile phone use, and relevant comorbidities, including diabetes and hypothyroidism. Pregnancy status was also not documented as an exclusion criterion in the available study description. These factors may influence symptom occurrence or the relationship between occupational exposure and symptoms. Fifth, a healthy worker effect cannot be excluded because workers who experience substantial symptoms may change jobs, transfer to less demanding duties, or leave employment. Sixth, if the same researcher assessed both repetitive movement exposure and symptoms without blinding, observer-related or common-method bias may have affected the findings. The available documentation does not establish whether separate assessors or blinding procedures were used. Seventh, the categorization of BCTQ scores into symptom-severity levels requires a clearly specified and justified reference. If these categories were not based on validated thresholds, misclassification of symptom severity may have occurred. Finally, the study was conducted at one company and may reflect workplace-specific characteristics that are not representative of other office-based populations. Future research should use clearly justified exposure and symptom classifications, include objective clinical assessment where feasible, recruit participants from multiple workplaces, and apply multivariable analyses to account for relevant confounders. Prospective studies would also help clarify the temporal relationship between repetitive movement exposure and the development of CTS-like symptoms

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## CONCLUSION

This study found a statistically significant association between repetitive movement exposure and CTS-like symptoms among office workers at PT Karya Bintang Mandiri. The high-exposure group had a greater proportion of respondents reporting moderate-to-severe symptoms than the low- and moderate-exposure groups. However, the observed pattern was not consistently monotonic, and the cross-sectional design does not allow causal conclusions. These findings should therefore be interpreted cautiously, and further studies using validated assessment methods and appropriate statistical analyses are needed to clarify this association.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest regarding this research.

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