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Association of Hand Physical Activity with Carpal Tunnel Syndrome in Packing Workers

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KEYWORDS

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DECLARATIONS

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ABSTRACT

Background: Carpal tunnel syndrome is a common work-related musculoskeletal disorder, particularly among individuals engaged in repetitive hand movements, such as packing workers, yet the specific association between hand physical activity and carpal tunnel syndrome in this population remains underexplored. **Objective:** To evaluate the association of hand physical activity with carpal tunnel syndrome among packing workers. **Methodology:** A cross-sectional study was conducted among 323 packing workers from various factories in Sialkot, Pakistan. Workers aged 18 to 35 years, both male and female, were included. Pregnant females, individuals with other hand abnormalities, or those younger than 18 or older than 35 years were excluded. Data collection was done using the Boston Carpal Tunnel Syndrome Questionnaire and the provocative Phalen test. Descriptive statistics were presented as frequencies and percentages, while the Spearman test was used for inferential statistics to evaluate the correlation between CTS and hand physical activity. The results, including the sum of BCTQ scores, were displayed in charts, tables, and graphs. **Results:** Among 323 packing workers, carpal tunnel syndrome prevalence was 68.8% in males and 31.6% in females. Age-wise, 63.8% of subjects were aged 25–35 years, while 36.2% were aged 18–25 years. Due to non-normal data distribution (Shapiro-Wilk test), Spearman's test was applied, showing a significant association between hand physical activity and carpal tunnel syndrome ($p<0.001$). **Conclusion**: The study found a high prevalence of carpal tunnel syndrome among packing workers, with a significant negative correlation between hand physical activity and this syndrome. Findings confirm a strong association between hand physical activity and carpal tunnel syndrome.

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INTRODUCTION

Musculoskeletal diseases (MSDs) occur when muscles, ligaments, tendons, nerves, bones, and joints are injured. MSDs are recognized as a significant occupational health risk, impacting workplace productivity and individual well-being.[1,2] Work-related musculoskeletal disorders (WMSDs) are often linked to physically demanding tasks, repetitive motions, awkward postures, and exposure to vibrations, leading to fatigue, stress, and reduced quality of life.[3,4] MSDs contribute to absenteeism, reduced productivity, and increased medical costs, ranging from mild discomfort to severe disability. Globally, carpal tunnel syndrome (CTS) is the most common nerve compression disorder.[5,6]

The CTS occurs when the median nerve is compressed at the wrist, causing pain, numbness, and weakness in the hand, which can radiate up the arm. Repetitive hand movements, obesity, pregnancy, and autoimmune diseases like rheumatoid arthritis are key risk factors.[7,8] Early symptoms include nocturnal hand numbness and swelling (brachialgia paresthetica nocturna), progressing to daytime pain and clumsiness in holding objects. Advanced stages involve muscle wasting in the thenar eminence.[9] Most CTS cases are idiopathic, characterized by tenosynovitis pressing on the median nerve, with recurring symptoms like paresthesia, pain, and motor weakness.[10] The carpal tunnel, located under the flexor retinaculum, houses the median nerve and nine tendons responsible for thumb and finger movements.

Compression of the median nerve within the tunnel can lead to CTS, causing pain, numbness, and weakness in the hand and wrist.[11,12] The most common peripheral compression neuropathy, affects about 3.8% of the general population and up to 15% of at-risk individuals, with middle-aged women being particularly vulnerable.[12] Risk factors include repetitive motions, prolonged awkward wrist positions, exposure to vibration, obesity, and certain medical conditions such as rheumatoid arthritis and diabetes.[13] The pathophysiology of CTS involves increased pressure in the carpal tunnel, leading to demyelination, ischemia, and nerve damage. Symptoms often begin as nocturnal hand tingling or pain, progressing to daytime discomfort and weakness. In advanced stages, muscle atrophy in the thenar eminence may occur.[14,15] Screening tools such as Phalen's test and Tinel's test are widely used, with varying sensitivity and specificity.[16] Packing workers, who frequently perform repetitive hand tasks, are at a higher risk of developing CTS. Researching the relationship between hand physical activity and CTS in this workforce is crucial for developing ergonomic interventions, improving workplace safety, reducing healthcare costs, and enhancing worker well-being and productivity.[17]

Understanding the link between repetitive hand movements and CTS is key to prevention and management strategies tailored to at-risk occupational groups. A lot of studies have been done on carpal tunnel syndrome or median nerve compressions, such as in butchers, office workers, dentists, health practitioners, teachers and other occupations in Iran, China, Turkey, Switzerland and other countries worldwide but in Pakistan prevalence of CTS and its impact on the functional status of individuals is studied among few holding population such as in obese patients, pregnant females, butchers, laborers, dentists, in various cities of Pakistan but, there remains a significant gap in understanding its prevalence and its association with hand physical activity or impact on functional status among packing workers in Pakistan, particularly in the city of Sialkot. This study stems from the need to address this gap in the literature and provide valuable insights into the prevalence and determinants of CTS among packing workers in Sialkot.

METHODOLOGY

This cross-sectional study was conducted to assess the association between hand physical activity and CTS among packing workers in factories in Sialkot, Pakistan. The study was completed within six months under the supervision of the University of Sialkot's ethical committee. Following ethical approval, data collection was carried out in various packing sections of factories and industries. A sample size of 323 participants was determined using non-probability convenient sampling. Participants were selected based on the inclusion criteria: age between 18 to 35 years, both male and female genders, workers with a minimum job span of three months, and those working at least seven hours per day. Exclusion criteria included individuals younger than 18 years or older than

35 years, unwilling participants, pregnant females, individuals with other hand conditions such as De'Quervain Tenosynovitis or Dupuytren's Contracture, or a history of hand, wrist, or arm surgery. The tools used for data collection included the Phalen test and the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ).

The Phalen test, a diagnostic tool for CTS, was utilized to identify symptoms of median nerve compression, with its sensitivity ranging from 42% to 91% and specificity from 55% to 98%[18]. The BCTQ, a self-reported questionnaire, assessed symptom severity and functional status through its two scales: the Symptom Severity Scale (SSS) with 11 questions and the Functional Status Scale (FSS) with 8 questions. Each question was scored on a Likert scale of 1 to 5, with higher scores indicating worse symptoms or functionality.[19]. Data collection involved inviting voluntary packing workers from factories and explaining the study's rationale, confidentiality, and expected outcomes. Informed consent was obtained from participants and factory management. The Phalen test was performed to assess CTS symptoms, while participants filled out the BCTQ with assistance and guidance provided as needed. Additional demographic and medical history data were also collected using a structured questionnaire. Data analysis was performed using SPSS Version 27.0.

Descriptive statistics were presented as frequencies and percentages, while the Spearman test was used for inferential statistics to evaluate the correlation between CTS and hand physical activity. The results, including the sum of BCTQ scores, were displayed in charts, tables, and graphs. A confidence interval of 95% and an acceptable margin of error of 5% were set for the analysis. Ethical considerations were strictly followed throughout the study. Participants were provided with detailed information about the study's objectives and methods and were allowed to ask questions or raise concerns before signing the consent form. Anonymity and confidentiality were ensured by restricting data access to authorized personnel and removing identifying information. Participants retained the right to withdraw from the study at any time, fostering a safe and ethical research environment.

RESULTS

Table 1 shows the distribution and prevalence of carpal tunnel syndrome (CTS) among packing workers based on various demographic and occupational factors. Most of the workers, 63.8%, were aged between 25-35 years, while 36.2% were between 18-25 years. Male workers were more affected by CTS, with a 68.8% prevalence compared to 31.6% in females, and males constituted a larger portion of the workforce (64.1%) compared to females (35.9%). Workers with 7-hour shifts had the highest prevalence of CTS (54.5%), followed by those working 8 hours (41.8%) and 6 hours (3.7%). Additionally, workers with 6-10 years of experience in packing were more prone to CTS (52.0%) compared to those with 1-5 years of experience (48.0%). Overall, the prevalence of CTS among packing workers, as determined by the provocative Phalen test, was 57.0%. These findings highlight the significant association of CTS with longer working hours, years of experience, and male gender in the packing industry. The Symptom Severity Scale (SSS) of the BCTQ highlights the most common and severe symptoms experienced by participants with CTS. Nighttime hand or wrist pain was most frequently rated as "moderate" by 40.2%, while 30.7% reported being woken up "occasionally" by pain during the past two weeks. During the daytime, 34.1% described the pain as "mild", and 38.7% experienced it "occasionally".

Table 1: Distribution and prevalence of carpal tunnel syndrome

Variables	Categories	Frequency (Percentage)
Age	18-25 years	117 (36.2%)
	26-35 years	206 (63.8%)
Gender	Male	207 (64.1%)
	Female	116 (35.9%)
Working Hours	6 hours	12 (3.7%)
	7 hours	176 (54.5%)
	8 hours	135 (41.8%)
Job Experience	1-5 years	155 (48.0%)
	6-10 years	168 (52.0%)
Phalen Test	Positive	184 (57.0%)
	Negative	139 (43.0%)
Prevalence of CTS	Male	126 (68.8%)
	Female	58 (31.6%)

Episodes of daytime pain lasting a "moderate" amount of time were reported by 32.2% of participants. Numbness was rated as "mild" by 29.4%, while 28.5% experienced "moderate" weakness in the hand or wrist. Tingling sensations were "mild" for 26.0%, and nighttime numbness or tingling was "moderate" for 30.0%. Additionally, 26.9% reported being woken up "occasionally" by numbness or tingling at night. Difficulty with grasping and using small objects was rated as "moderate" by 29.7%. Table No 4 shows a significant negative correlation between hand physical activity and carpal tunnel syndrome (CTS) severity. Higher physical activity was associated with lower symptom severity (SSC score, r=-0.23, p=0.001), better functional status (FSS score, r=-0.303, p=0.001), and reduced overall CTS impact (BCTQ score, r=-0.27, p=0.001). These results suggest that increased hand physical activity is linked to less severe CTS symptoms and improved hand functionality. The results highlight the significant impact of CTS symptoms, particularly pain, numbness, and tingling, with greater severity noted at night.

DISCUSSION

The primary objective of the current study was to

Table 2: Boston Carpal Tunnel Questionnaire

Symptom Severity Scale	1	2	3	4	5
How severe is the hand or wrist pain that you have at night?	63 (19.5%)	130 (40.2%)	84 (26.0%)	33 (10.2%)	13 (4.0%)
How often did hand or wrist pain wake you up during a typical night in the past two weeks?	62 (19.2%)	99 (30.7%)	93 (28.8%)	46 (14.2%)	23 (7.1%)
Do you typically have pain in your hand or wrist during the daytime?	97 (30.0%)	110 (34.1%)	63 (19.5%)	34 (10.5%)	19 (5.9%)
How often do you have hand or wrist pain during the daytime?	88 (27.2%)	125 (38.7%)	62 (19.2%)	37 (11.5%)	11 (3.4%)
How long on average does an episode of pain last during the daytime?	69 (21.4%)	83 (25.7%)	104 (32.24%)	48 (14.9%)	19 (5.9%)
Do you have numbness (loss of sensation) in your hand?	62 (19.2%)	95 (29.4%)	81 (25.1%)	61 (18.9%)	24 (7.4%)
Do you have a weakness in your hand or wrist?	63 (19.5%)	89 (27.6%)	92 (28.5%)	54 (16.7%)	25 (7.7%)
Do you have tingling sensations in your hand?	71 (22.0%)	84 (26.0%)	74 (22.9%)	68 (21.1%)	26 (8.0%)
How severe is numbness (loss of sensation) or tingling at night?	54 (16.7%)	82 (25.4%)	97 (30.0%)	56 (17.3%)	34 (10.5%)
How often did hand numbness or tingling wake you up during a typical night during the past two weeks?	51 (15.8%)	87 (26.9%)	86 (26.6%)	69 (21.4%)	30 (9.3%)
Do you have difficulty with the grasping and use of small objects such as keys or pens?	57 (17.6%)	90 (27.9%)	96 (29.7%)	55 (17.0%)	25 (7.7%)

Table 2: Correlation between hand physical activity and carpal tunnel syndrome

Hand Physical Activity	Phalen Test	p-value
SSC Score	-0.23	<0.001
FSS Score	-0.303	<0.001
BCTQ Score	-0.27	<0.001

associate hand physical activity with carpal tunnel syndrome among packing workers. This study included 323 packing workers aged 18 to 35 years to evaluate the hand physical activity with carpal tunnel syndrome among packing workers of various factories in Sialkot. The current study uses BCTQ and the provocative Phalen test as an assessment tool. The current study states that there is a significant prevalence of carpal tunnel syndrome. On the contrary, another cross-sectional study was performed in 2022 with an aim of how common carpal tunnel syndrome was, 65 female logistics workers were included in their study. It is thought that between 1% and 5% of people in the community have CTS. According to PT. X, the company still uses people to pack soap and noodles.

The BCTQ and Phalen's test are used to look into CTS issues, their results showed that 61.5% prevalence of CTS.[20] The current study states that there is a significant association between hand physical activity and carpal tunnel syndrome among packing workers. The previous study was conducted in 2021 in Lahore at Sharif Trust Hospital and included 150 participants, results showed that most of the people who filled the Boston Questionnaire had moderate symptoms i.e. 39.3%, and light functional limitation i.e. 42%.[21] The current study shows there is a significant association between hand physical activity and carpal tunnel syndrome among packing workers. On the contrary, the previous study was done in 2019 to evaluate how pain in CTS patients affects the quality of life, The visual analogue scale and Boston questionnaire were used as an assessment tool the results showed that there is no significant relationship in QoL i.e. p-value is less great than 0.005.[22]

The results show that there is an association of hand physical activity with carpal tunnel syndrome among workers. The previous studies do not indicate if there is any association between hand physical activity with carpal tunnel syndrome in packing workers, the extent to which the association must considered between repetitive movements of hand and wrist in packing workers and CTS is a question arising from the research.[23] The results show that there is an association of hand physical activity with carpal tunnel syndrome in BCTQ scores among workers. Another study was done to find out what causes carpal tunnel syndrome (CTS) in people who work in agro-export businesses in Ica, Peru. To be sure of having CTS in our study, you had to meet two conditions: have at least one positive screening test (Tinel or Phalen) and get a possible diagnosis of CTS from the Kamath and Stothard Questionnaire.

The result differs from our finding that (CTS) was common among Peruvian agro-export workers in the production, packing, and management areas.[24] The current study does not show any link between CTS and hand awkward position. On the contrary, cross-sectional research was conducted in 2022 among tailors to link between type of work and number of cases of CTS. Their results showed no significant relation between the determinants, but, there was a link between repetitive movements and awkward hand positioning with CTS.[25] The current study shows that CTS negatively correlates with hand physical activity but does not explain any difference between hand and wrist symptoms identically. In a previous study percentage of people with clinically proven CTS was 9.6%, 22% of people had symptoms in their wrists and 15% had their symptoms in their hands.[26]

CONCLUSION

The study, association of hand physical activity with carpal tunnel syndrome in packing workers shows significant prevalence of carpal tunnel syndrome among packing workers and carpal tunnel syndrome negatively correlates with hand physical activity. There is a significant association between hand physical activity and carpal tunnel syndrome.

DECLARATIONS

Consent to participate: Written consent had been taken from patients. All methods were

performed following the relevant guidelines and regulations.

Availability of data and materials: Data will be available on request. The corresponding author will submit all dataset files.

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