

OCCURRENCE, FUNCTIONAL STATUS AND SEVERITY OF CARPAL TUNNEL SYNDROME AMONG WAITERS”: A DESCRIPTION CROSS-SECTIONAL STUDY

Original Research

Manahil Shahid^{1*}, Raiha Batoof², Zainab Qureshi², Farwah Tabassum², Aamara Ishaq², Rana Muhammad Hashir Ali², Abdullah Bin Khalid².

¹PhD Scholar and Lecturer, Faculty of Foundation University College of Physical Therapy (FUCP), Foundation University Islamabad (FUI), Islamabad, Pakistan.

²Student, Foundation University College of Physical Therapy (FUCP), Foundation University Islamabad (FUI), Islamabad, Pakistan.

Corresponding Author: Manahil Shahid, PhD Scholar and Lecturer, Faculty of Foundation University College of Physical Therapy (FUCP), Foundation University Islamabad (FUI), Islamabad, Pakistan, manahil.shahid@fui.edu.pk

Acknowledgement: The authors sincerely acknowledge all participating restaurant workers for their cooperation and time.

Conflict of Interest: None

Grant Support & Financial Support: None

ABSTRACT

Background: Carpal tunnel syndrome (CTS) is the most prevalent entrapment neuropathy of the upper limb and is commonly linked to repetitive wrist motion, sustained gripping, and prolonged hand postures. Occupational groups performing manual and repetitive tasks are particularly vulnerable. Restaurant waiters routinely engage in tray carrying, gripping, and repetitive wrist movements for extended hours, potentially increasing their risk of CTS. Despite this occupational exposure, limited evidence exists regarding CTS among waiters in Pakistan.

Objective: To determine the occurrence, symptom severity, and functional status of carpal tunnel syndrome among waiters working in restaurants in Islamabad and Rawalpindi.

Methods: A descriptive cross-sectional study was conducted over 14 months among 378 full-time waiters aged 18–45 years recruited from restaurants, cafés, and fast-food outlets using non-probability convenience sampling. Screening for CTS was performed using the CTS-6 diagnostic tool. Participants meeting the diagnostic cutoff underwent further evaluation with the Boston Carpal Tunnel Questionnaire (BCTQ), including the Symptom Severity Scale (SSS) and Functional Status Scale (FSS). Data were analyzed using SPSS version 21. Frequencies and percentages were calculated to describe demographic characteristics, CTS occurrence, symptom severity, and functional status.

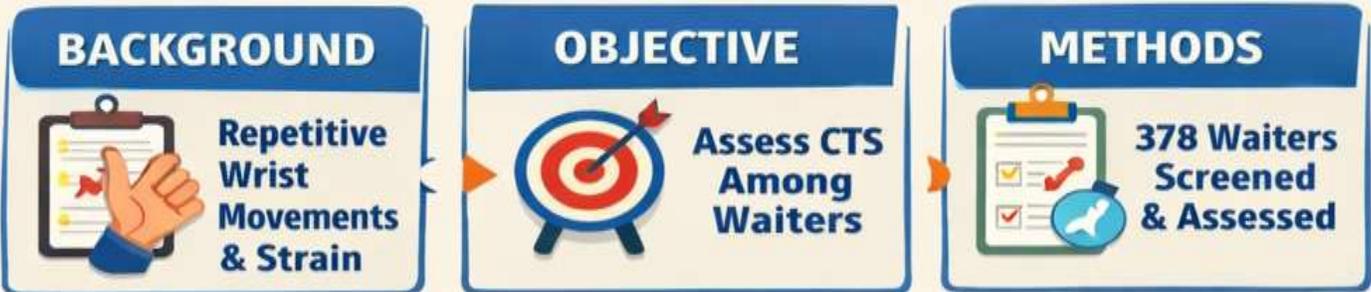
Results: CTS was identified in 4.5% (n = 17) of participants, while 95.5% (n = 361) were negative. Among the total sample, 0.8% (n = 3) had mild symptoms, 2.6% (n = 10) moderate symptoms, and 1.1% (n = 4) severe symptoms; no cases of very severe CTS were observed. Functional assessment demonstrated that 96.6% (n = 365) maintained normal hand function, whereas 3.4% (n = 13) exhibited mild to severe functional limitations. A proportionally higher occurrence of CTS was observed among participants aged 39–45 years (20%), smokers (7.3%), individuals with diabetes (28.5%), and those classified as overweight (8.3%).

Conclusion: Although the overall occurrence of CTS among waiters was relatively low, clinically relevant symptoms and functional limitations were present in a subset of workers. These findings underscore the need for early screening, ergonomic interventions, and preventive occupational health strategies to minimize progression and preserve hand function in this workforce.

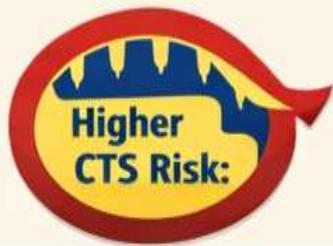
Keywords: Carpal Tunnel Syndrome, Musculoskeletal Diseases, Occupational Health, Peripheral Nerve Compression Syndromes, Prevalence, Risk Factors, Work-Related Injuries.



Carpal Tunnel Syndrome in Waiters



RESULTS



CONCLUSION:

Early Screening & Ergonomic Interventions Needed

INTRODUCTION

Work-related musculoskeletal disorders (WMSDs) remain one of the most prevalent causes of occupational injury and long-term disability worldwide, substantially compromising productivity, work participation, and overall quality of life (1). These conditions are particularly common in occupations characterized by repetitive movements, sustained postures, and physical strain. Among such professions, waiters represent an understudied yet highly vulnerable group. Their routine tasks—including repetitive upper-limb activity, prolonged standing, manual handling of heavy trays, and maintenance of awkward wrist and shoulder positions—are often performed under time pressure with minimal opportunities for rest. Regional evidence from Islamabad and Rawalpindi has shown that 48.4% of waiters report musculoskeletal disorders, underscoring a considerable occupational health burden in this population (2). Comparable findings from Gondar City, Ethiopia, revealed that 51.6% of restaurant workers experienced wrist or hand discomfort, reinforcing the high prevalence of upper-limb disorders within the service industry (3). The wrist joint is anatomically complex and biomechanically exposed, making it particularly susceptible to repetitive strain. The carpal tunnel, a narrow osteofibrous canal, contains the median nerve and flexor tendons; sustained mechanical stress within this confined space may result in median nerve compression, clinically manifesting as carpal tunnel syndrome (CTS), the most common entrapment neuropathy of the upper extremity (3-5). CTS typically presents with pain, tingling, numbness, and paresthesia affecting the thumb, index, middle, and radial half of the ring finger, often worsening at night and interfering with fine motor tasks (4). Occupational risk factors such as repetitive wrist and finger motion, forceful exertion, awkward positioning, and vibration exposure have been consistently implicated in the pathogenesis of CTS (6). In addition, non-occupational factors—including advancing age, female sex, obesity, pregnancy, diabetes mellitus, and genetic predisposition—may amplify susceptibility (7). Globally, CTS affects approximately 3.8–5% of the general population, with significantly higher rates among workers engaged in repetitive and force-intensive activities (8). A systematic review further identified force, posture, and repetition as key determinants of musculoskeletal disorders in the catering sector, emphasizing the occupational relevance of median nerve compression in this context (9).

Beyond repetitive wrist use, restaurant workers encounter multiple ergonomic and environmental hazards, including prolonged standing, heavy lifting, slips, burns, exposure to high temperatures, cooking fumes, and psychosocial stressors. Surveys indicate that up to 70% of catering workers report musculoskeletal symptoms, particularly involving the upper limbs (10). European data similarly document a high prevalence of back, neck, and upper-limb pain among workers in the HoReCa industry, highlighting the broader occupational health implications within hospitality services (11). In Punjab alone, waiters constitute a substantial workforce distributed across approximately 30,000 registered restaurants, reflecting the magnitude of potential occupational exposure (12). Despite this considerable workforce and documented musculoskeletal burden, focused investigation into CTS among waiters—particularly within Rawalpindi and Islamabad—remains limited, creating a significant gap in occupational health literature. Pathophysiologically, CTS arises from increased pressure within the carpal tunnel, leading to impaired median nerve conduction and subsequent sensory and motor dysfunction (13). Early recognition relies primarily on clinical evaluation of characteristic symptoms such as nocturnal paresthesia, numbness in the radial three and a half digits, and hand weakness (14). Timely intervention is crucial, as conservative strategies—including wrist splinting, ergonomic modification, activity adjustment, and structured rehabilitation—can effectively mitigate progression, whereas delayed diagnosis may necessitate surgical decompression (15). Failure to address CTS not only compromises functional capacity and work performance but also imposes socioeconomic consequences for individuals and employers alike. Given the physically demanding nature of waiting services, the high prevalence of upper-limb complaints in similar occupational settings, and the paucity of local epidemiological data, it is imperative to systematically examine CTS within this workforce. The present study therefore seeks to answer the research question: what is the frequency of carpal tunnel syndrome among waiters in Rawalpindi and Islamabad, and how does it influence symptom severity and functional performance? It is hypothesized that a substantial proportion of waiters will demonstrate symptoms consistent with CTS, reflecting occupational exposure to repetitive and forceful wrist activities. By quantifying frequency, assessing symptom severity, and evaluating functional impact, this study aims to generate evidence to inform preventive ergonomic strategies, early screening initiatives, and occupational health surveillance programs. Ultimately, such evidence may contribute to improved working conditions, reduced long-term disability, enhanced productivity, and better overall well-being among waiters in this region.

METHODS

A descriptive cross-sectional study was conducted over a one-year period from November 2024 to December 2025 after obtaining ethical approval from the Ethical Review Committee of Foundation University School of Health Sciences (Ref: FF/FUMC/215-613/Phy/25).

The study was designed to determine the frequency, symptom severity, and functional impact of carpal tunnel syndrome (CTS) among waiters working in Islamabad and Rawalpindi. All procedures were carried out in accordance with institutional ethical standards. Written informed consent was obtained from each participant prior to enrollment, and confidentiality of personal information was strictly maintained. Participants were informed of their right to withdraw from the study at any stage without any consequences. Data were collected from waiters employed in restaurants, cafés, and fast-food outlets using a non-probability purposive sampling technique. The sample size was estimated using RaoSoft sample size calculation software. The calculation was based on publicly available data from the Pakistan Bureau of Statistics and Open Data Pakistan, which reported more than 30,000 registered restaurants in Punjab, including approximately 2,425 in Rawalpindi (14). Assuming an average of ten waiters per restaurant, the estimated population size was derived accordingly, and a minimum sample of 378 participants was determined to achieve adequate statistical precision. Full-time waiters aged 18–45 years, with at least one year of occupational experience and working a minimum of 6–8 hours per day, were included irrespective of gender. Exclusion criteria comprised a history of recent wrist fracture, soft tissue injury, trauma or surgery involving the wrist, previously diagnosed inflammatory arthropathies such as rheumatoid arthritis, systemic lupus erythematosus, or psoriatic arthritis, congenital wrist anomalies, and use of analgesic medication within the preceding two days to avoid symptom masking.

Screening for CTS was performed using the CTS-6 diagnostic tool, a validated clinical instrument integrating symptom history and focused physical examination with high diagnostic accuracy (sensitivity 87%, specificity 91%) (16). The history component evaluated the presence of nocturnal numbness and tingling in the median nerve distribution, specifically the thumb, index, middle, and radial half of the ring finger, with responses recorded dichotomously. The physical examination included assessment of thenar muscle atrophy or weakness through manual muscle testing, Phalen's test, Tinel's sign at the wrist, and two-point discrimination testing of digits innervated by the median nerve. Each component contributed to a cumulative score ranging from 0 to 26, and a score of ≥ 12 was considered indicative of CTS (14). Participants who met the diagnostic threshold subsequently completed the Boston Carpal Tunnel Questionnaire (BCTQ) to evaluate symptom severity and functional limitation. The BCTQ consists of two subscales: the Symptom Severity Scale (SSS; score range 11–55) and the Functional Status Scale (FSS; score range 8–40). The instrument demonstrates excellent reliability, with reported Intraclass Correlation Coefficients of 0.91 for symptom severity and 0.93 for functional status (17,18). Severity grading was categorized as asymptomatic, mild, moderate, severe, or extremely severe based on established scoring criteria (19,20). Questionnaires were administered under supervision to ensure clarity of instructions and to minimize response bias. Data collection was conducted in two sequential phases. Initially, all eligible participants underwent CTS-6 screening. Those who achieved the diagnostic cutoff were then assessed using the BCTQ. All assessments were performed by trained personnel to maintain procedural consistency and reduce inter-examiner variability. Data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 21. Descriptive statistics, including means and standard deviations for continuous variables and frequencies and percentages for categorical variables, were used to summarize demographic characteristics and occupational profiles. The prevalence of CTS, along with severity and functional impairment categories, was calculated using frequency distribution analysis.

RESULTS

A total of 378 waiters participated in the study. The majority were male ($n = 364$, 96.3%), while females constituted 3.7% ($n = 14$). Most participants were right-hand dominant ($n = 325$, 86%), followed by left-hand dominant ($n = 44$, 11.6%) and ambidextrous individuals ($n = 9$, 2.4%). Regarding marital status, 65.3% ($n = 247$) were single, 33.9% ($n = 128$) were married, and less than 1% were divorced or widowed. A substantial proportion were non-smokers ($n = 282$, 74.6%), while 25.4% ($n = 96$) reported active smoking. Diabetes mellitus was present in 1.9% ($n = 7$) of participants, whereas 98.1% ($n = 371$) were non-diabetic. More than half of the sample (53.7%, $n = 203$) belonged to the 18–24-year age group, followed by 27.5% ($n = 104$) aged 25–31 years, 10.8% ($n = 41$) aged 32–38 years, and 7.9% ($n = 30$) aged 39–45 years. Based on body mass index (BMI), 48.9% ($n = 185$) had normal weight, 25.4% ($n = 96$) were overweight, 19.8% ($n = 75$) were underweight, and 5.8% ($n = 22$) were classified as obese. Screening using the CTS-6 diagnostic tool identified 17 participants with carpal tunnel syndrome, yielding a prevalence of 4.5% ($n = 17$), while 95.5% ($n = 361$) tested negative. Among the 17 diagnosed cases, symptom severity distribution based on Boston Carpal Tunnel Questionnaire scoring demonstrated that 17.6% ($n = 3$) had mild symptoms, 58.8% ($n = 10$) had moderate symptoms, and 23.5% ($n = 4$) had severe symptoms. No participant fell into the very severe symptom category. Functional status assessment revealed that 23.5% ($n = 4$) were functionally asymptomatic despite diagnostic positivity, 69.2% ($n = 9$) exhibited mild functional limitation, 23.0% ($n = 3$) demonstrated moderate limitation, and 7.0% ($n = 1$) experienced severe functional restriction. No case was categorized as very severe functional impairment. Cross-tabulation analyses examined the distribution of CTS according to selected demographic and health-related variables. Among smokers, 7.3% ($n = 7/96$)

were CTS-positive compared to 3.5% (n = 10/282) among non-smokers. Diabetes was present in seven participants, of whom 28.5% (n = 2/7) were CTS-positive, whereas only 4% (n = 15/371) of non-diabetic participants were diagnosed with CTS. With respect to BMI categories, CTS prevalence was 4% (n = 3/75) among underweight individuals, 3.2% (n = 6/185) among those with normal BMI, and 8.3% (n = 8/96) among overweight participants. None of the obese participants (n = 22) were CTS-positive. Age-stratified distribution demonstrated the highest proportion of CTS among participants aged 39–45 years (20%, n = 6/30), followed by 32–38 years (7.3%, n = 3/41), 18–24 years (2.9%, n = 6/203), and 25–31 years (1.9%, n = 2/104). Overall, CTS cases were numerically concentrated in younger age groups due to their larger representation in the sample; however, proportionally higher frequencies were observed in older participants. Moderate symptom severity and mild functional limitation were the most common clinical patterns among diagnosed individuals.

Table 1: Participant Demographics

Variable	Category	Frequency (%)
Gender	Male	364 (96.3%)
	Female	14 (3.7%)
Dominant Hand	Right	325 (86%)
	Left	44 (11.6%)
	Ambidextrous	9 (2.4%)
Marital Status	Single	247 (65.3%)
	Married	128 (33.9%)
	Divorced	2 (0.5%)
	Widowed	1 (0.3%)
Smoking History	Smoker	96 (25.4%)
	Non-smoker	282 (74.6%)
Diabetes	Yes	7 (1.9%)
	No	371 (98.1%)
Age (years)	18–24	203 (53.7%)
	25–31	104 (27.5%)
	32–38	41 (10.8%)
	39–45	30 (7.9%)
BMI	Underweight	75 (19.8%)
	Normal	185 (48.9%)
	Overweight	96 (25.4%)
	Obese	22 (5.8%)
Total Participants		378 (100%)

Table 2: Occurrence, Severity, and Functional Status of CTS

CTS Measure	Category	Frequency (n)	Percent (%)
Occurrence	Positive	17	4.5
	Negative	361	95.5
Severity	Mild (12–22)	3	17.6
	Moderate (23–33)	10	58.8
	Severe (34–44)	4	23.5
	Very Severe (45–55)	0	0
Functional Status	Asymptomatic	4	23.5
	Mild (9–16)	9	69.2
	Moderate (17–24)	3	23.0
	Severe (25–32)	1	7.0
	Very Severe (33–40)	0	0
Total Participants		17	100

Table 3: Cross-Tabulation of Smoking, Diabetes, BMI, and Age with CTS Status

Variable	Category	CTS Positive n (%)	CTS Negative n (%)	Total n (%)
Smoking	Smoker	7 (7.3)	89 (92.7)	96 (25.4)
	Non-Smoker	10 (3.5)	272 (96.5)	282 (74.6)
Diabetes	Yes	2 (28.5)	5 (71.5)	7 (1.9)
	No	15 (4)	356 (96)	371 (98.1)
BMI	Underweight	3 (4)	72 (96)	75 (19.8)
	Normal	6 (3.2)	179 (96.8)	185 (48.9)
	Overweight	8 (8.3)	88 (91.7)	96 (25.4)
	Obese	0 (0)	22 (100)	22 (5.8)
Age (years)	18–24	6 (2.9)	197 (97.1)	203 (53.7)
	25–31	2 (1.9)	102 (98.1)	104 (27.5)
	32–38	3 (7.3)	38 (92.7)	41 (10.8)
	39–45	6 (20)	24 (80)	30 (7.9)

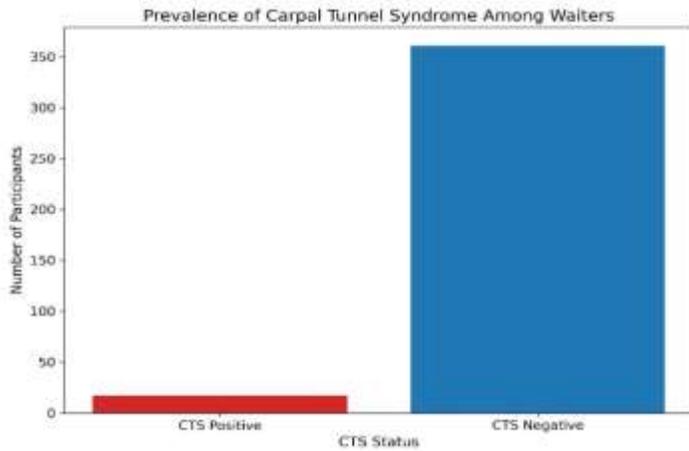


Figure 1 Prevalence of Carpal tunnel Syndrome Among Waiters

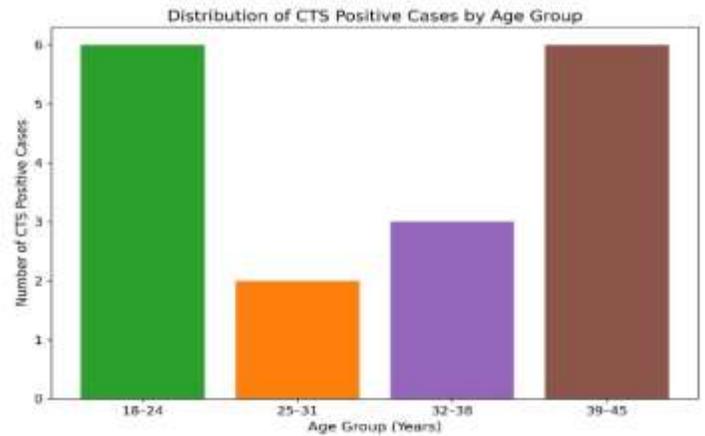
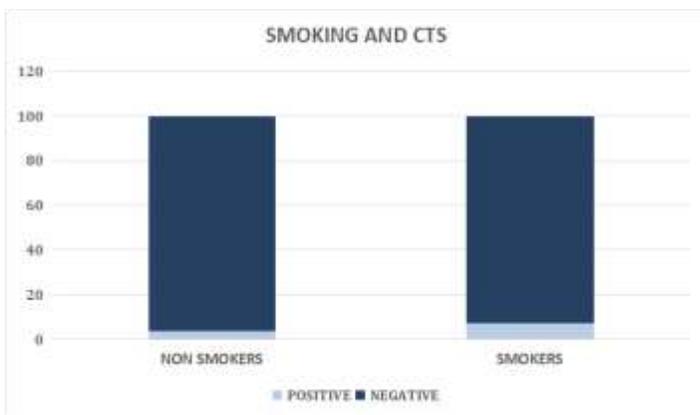
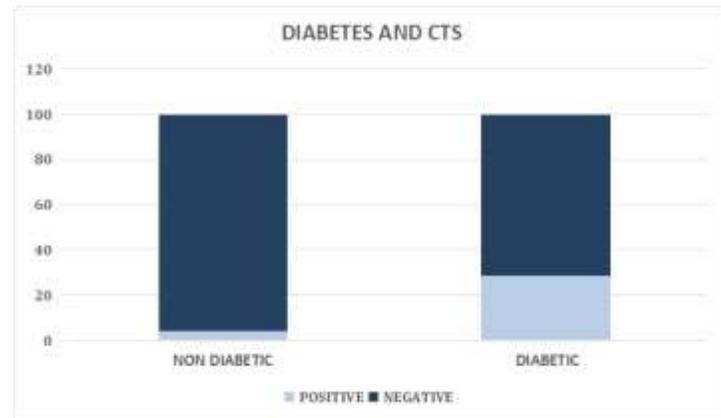


Figure 1 Distribution of CTS Positive Cases by Age Group



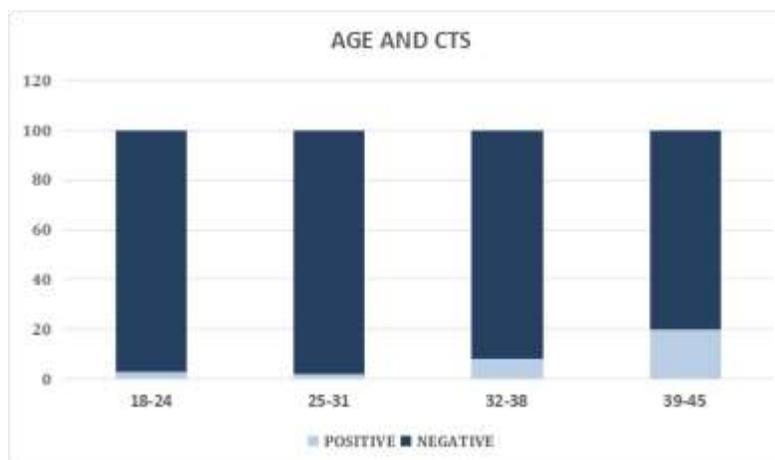
Cross Tabulation of Smoking History and CTS

Figure 3 Cross Tabulation of Smoking History and CTS



Cross Tabulation of Diabetes and CTS

Figure 4 Cross Tabulation of Diabetes and CTS



Cross Tabulation of Age and CTS

Figure 5 Cross Tabulation of Age and CTS

DISCUSSION

The present study evaluated the prevalence, clinical severity, and functional impact of carpal tunnel syndrome among restaurant waiters in Rawalpindi and Islamabad and examined its association with selected demographic and health-related variables. The overall prevalence of CTS was 4.5%, with most affected individuals demonstrating mild to moderate symptom severity and predominantly mild functional limitation. These findings suggest that while CTS was present within this occupational group, the majority of diagnosed cases were at relatively early clinical stages. The observation that higher proportions of CTS were found among older participants, smokers, overweight individuals, and those with diabetes supports the multifactorial nature of CTS, where occupational exposure interacts with individual susceptibility factors (2,7). The reported prevalence was lower than figures described in several international occupational cohorts, particularly among industrial and office-based workers engaged in highly repetitive or force-intensive tasks. Previous investigations in such settings documented comparatively higher CTS rates, likely attributable to continuous repetitive motion, sustained wrist flexion, and prolonged mechanical loading. In contrast, waiting tasks, although physically demanding, may involve intermittent movement patterns and variation in hand activity, potentially reducing sustained intracarpal pressure. The relatively young age distribution of the present sample, with more than half of participants aged 18–24 years, may also have contributed to the lower prevalence, given that cumulative exposure and degenerative changes increase with age (12,15). Nevertheless, biomechanical evidence has demonstrated that repetitive gripping and wrist flexion–extension significantly elevate intracarpal pressure, providing a plausible mechanistic link between occupational strain in waiters and median nerve compression (11). Symptom distribution in the current study further supports the concept of early-stage disease predominance. Most CTS-positive participants exhibited mild (17.6%) or moderate (58.8%) symptoms, with no cases categorized as very severe. Functional limitations were largely minimal, and a subset of diagnosed individuals reported no functional restriction despite positive screening. Earlier literature has indicated that CTS initially affects sensory fibers before motor impairment becomes evident, which aligns with the pattern observed in this cohort (12). Additional studies have shown that functional decline tends to emerge in more advanced stages of the condition (15). The relatively preserved functional status in this population underscores the potential benefit of early conservative management strategies, including ergonomic modification, activity adaptation, splinting, and targeted physical therapy, to prevent progression.

Age demonstrated a proportional relationship with CTS prevalence, with the highest rate observed in the 39–45-year age group (20%). Similar trends have been documented in previous epidemiological research, where advancing age was associated with increased CTS risk, possibly due to cumulative mechanical exposure, reduced nerve elasticity, and age-related connective tissue changes (9,10). Body mass index also appeared to influence risk, as overweight participants exhibited the highest prevalence (8.3%). Prior research has consistently identified elevated BMI as a significant risk factor, potentially mediated by increased hydrostatic pressure within the carpal tunnel and systemic inflammatory pathways (10,13). The absence of CTS among obese participants in the present study contrasts with evidence of a dose-response association between BMI and CTS risk reported elsewhere (11–14). This discrepancy is likely attributable to the small number of obese participants, limiting statistical power to detect associations in this subgroup. Smoking and diabetes emerged as notable correlates. Smokers demonstrated a higher prevalence of CTS compared to non-smokers, consistent with literature suggesting that nicotine-induced vasoconstriction and impaired peripheral microcirculation may contribute to median nerve vulnerability (9,12). However, some prior studies have reported inconsistent associations between smoking and CTS, reflecting potential variability in exposure intensity, duration, and population characteristics (19). The markedly higher prevalence among diabetic participants aligns with well-established evidence linking diabetes to peripheral neuropathy and increased susceptibility to entrapment neuropathies (19,20). Hyperglycemia-induced connective tissue glycation and microvascular compromise likely exacerbate median nerve compression in such individuals. The study possessed several strengths. It utilized validated diagnostic and outcome measures, including the CTS-6 and the Boston Carpal Tunnel Questionnaire, enhancing clinical accuracy and standardized severity classification (21). The inclusion of participants from multiple restaurant settings and a relatively large sample size improved the representativeness of the findings within the selected urban region. Furthermore, the study addressed an understudied occupational group in Pakistan, contributing novel data to the field of occupational health and hand rehabilitation.

Despite these strengths, certain limitations warrant consideration. The cross-sectional design precluded causal inference, limiting conclusions regarding temporal relationships between risk factors and CTS development. The predominance of male participants restricted evaluation of sex-based differences, particularly relevant given the higher CTS prevalence often reported among females. Non-probability sampling may have introduced selection bias and limited broader generalizability. Additionally, the reliance on clinical screening without electrodiagnostic confirmation may have resulted in misclassification, particularly in borderline cases. Statistical analyses were descriptive; inferential testing would have strengthened conclusions regarding associations. Occupational exposure

variables such as duration of tray carrying, average load weight, shift length, and ergonomic workstation characteristics were not quantified, which may have provided deeper insight into work-related risk patterns. Future research should incorporate probability-based sampling techniques, balanced gender representation, and longitudinal designs to establish temporal relationships and incidence rates. Inclusion of nerve conduction studies could enhance diagnostic precision. Detailed ergonomic assessments and quantification of biomechanical exposure would allow more refined risk modeling. Analytical approaches such as multivariable regression could further clarify independent predictors while adjusting for confounders (22,23). Expanding investigation to other service-sector occupations would also support comparative occupational risk profiling. Overall, the findings highlighted that CTS was present among restaurant waiters, predominantly at early clinical stages, with identifiable demographic and metabolic correlates. The results underscored the importance of occupational screening, ergonomic interventions, and early conservative management to prevent progression and preserve hand function. While the prevalence was modest, the presence of modifiable risk factors emphasizes the need for integrated workplace health strategies within the hospitality sector.

CONCLUSION

The present study concluded that carpal tunnel syndrome was identified in a small proportion of restaurant waiters, with most affected individuals demonstrating early-stage symptoms and largely preserved functional capacity. Although the overall occupational burden appeared limited, the presence of sensory complaints and identifiable risk patterns underscored the relevance of timely recognition within this workforce. By addressing the objective of determining frequency, severity, and functional impact, the findings contribute valuable occupational health evidence for an underexplored population. The study highlights the practical importance of routine screening, ergonomic awareness, and early conservative intervention to prevent progression, safeguard hand function, and support long-term work productivity in the hospitality sector.

AUTHOR CONTRIBUTIONS

Author	Contribution
Manahil Shahid*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Raiha Batool	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Zainab Qureshi	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Farwah Tabassum	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Aamara Ishaq	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Rana Muhammad Hashir Ali Khalid	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Abdullah Bin Khalid	Contributed to study concept and Data collection Has given Final Approval of the version to be published

REFERENCES

1. Tegenu H, Gebrehiwot M, Azanaw J, Akalu TY. Self-Reported Work-Related Musculoskeletal Disorders and Associated Factors among Restaurant Workers in Gondar City, Northwest Ethiopia, 2020. Haughton J, editor. *Journal of Environmental and Public Health*. 2021 Jun 7;2021:1–9.
2. Haider HA, Hashmi L, Habib H, Yaqoob H, Shaukat A, Altaf F, et al. Prevalence of musculoskeletal disorders among waiters in Islamabad and Rawalpindi. *J Health Rehabil Res*. 2024;4(3).
3. Osiak K, Elnazir P, Walocha JA, Pasternak A. Carpal tunnel syndrome: state-of-the-art review. *Folia Morphologica*. 2021 Nov 9;81(4).
4. Erick P, Benjamin K, Raditloko S, Tapera R, Mbongwe B. Risk factors for self-reported carpal tunnel syndrome among hairstylists in Gaborone, Botswana. *International Journal of Occupational Medicine and Environmental Health*. 2021 Jun 28;34(3):437–50.
5. AlHussain AH, Alshahir AA, AlNaqa FH, Alsaygh EF, Alquwaiz IA, Alqahtani MS. Prevalence and Predictors of Carpal Tunnel Syndrome Symptoms Among Teachers in Riyadh: A Cross-Sectional Study. *Cureus*. 2023 Feb 15;
6. Lampainen K, Shiri R, Auvinen J, Karppinen J, Ryhänen J, Hulkkonen S. Weight-Related and Personal Risk Factors of Carpal Tunnel Syndrome in the Northern Finland Birth Cohort 1966. *Journal of Clinical Medicine* [Internet]. 2022 Mar 10 [cited 2022 Nov 22];11(6):1510.
7. Hassan A, Beumer A, Kuijer PPFM, van der Molen HF. Work-relatedness of carpal tunnel syndrome: Systematic review including meta-analysis and GRADE. *Health Science Reports*. 2022 Nov;5(6).
8. Alexandra-Daniela Rotaru-Zavaleanu, Cristian Virgil Lungulescu, Marius Gabriel Bunescu, Ramona Constantina Vasile, Gheorman V, Andrei Gresita, et al. Occupational Carpal Tunnel Syndrome: a scoping review of causes, mechanisms, diagnosis, and intervention strategies. *Frontiers in public health*. 2024 May 22;12.
9. Trillos-Chacón MC, Castillo-M JA, Tolosa-Guzman I, Sánchez Medina AF, Ballesteros SM. Strategies for the prevention of carpal tunnel syndrome in the workplace: A systematic review. *Applied Ergonomics*. 2021 May;93(93):103353.
10. El-Helaly M, Balkhy HH, Vallenius L. Carpal tunnel syndrome among laboratory technicians in relation to personal and ergonomic factors at work. *J Occup Health*. 2017;59(6):513-20.
11. Musolin KM, Ramsey JG. Carpal tunnel syndrome prevalence: an evaluation of workers at a raw poultry processing plant. *Int J Occup Environ Health*. 2017;23(4):282-90.
12. Alharbi A, Alotaibi K, AlZabin A, Almajed E, Alotaibi G, Alqntash N, et al. Carpal tunnel syndrome symptoms and their associated factors among plastic surgeons in Saudi Arabia: a cross-sectional study. *BMC Musculoskelet Disord*. 2025;26(1):717.
13. Altuntaş YD, Çankaya T. Effects of working years in cold environment on the musculoskeletal system and carpal tunnel symptoms. *Agri*. 2020;32(3):120-7.
14. Lavé A, Gondar R, Demetriades AK, Meling TR. Ergonomics and musculoskeletal disorders in neurosurgery: a systematic review. *Acta Neurochir (Wien)*. 2020;162(9):2213-20.
15. Maghsoudipour M, Hosseini F, Coh P, Garib S. Evaluation of occupational and non-occupational risk factors associated with carpal tunnel syndrome in dentists. *Work*. 2021;69(1):181-6.
16. Yang Y, Ding H, Qiao Y. [Investigation and analysis of wrist musculoskeletal disorders by ultrasound physicians]. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi*. 2025;43(11):850-3.
17. Alhusain FA, Almohrij M, Althukeir F, Alshater A, Alghamdi B, Masuadi E, et al. Prevalence of carpal tunnel syndrome symptoms among dentists working in Riyadh. *Ann Saudi Med*. 2019;39(2):104-11.
18. Singh AD, Aggarwal N, Mohan BP, Madhu D, Song G, Bhatt A, et al. Prevalence of endoscopy-related injuries and their impact on clinical practice: a systematic review and meta-analysis. *Endoscopy*. 2024;56(8):612-9.

19. Prasad DA, Appachu D, Kamath V, Prasad DK. Prevalence of low back pain and carpal tunnel syndrome among dental practitioners in Dakshina Kannada and Coorg District. *Indian J Dent Res.* 2017;28(2):126-32.
20. Epstein S, Sparer EH, Tran BN, Ruan QZ, Dennerlein JT, Singhal D, et al. Prevalence of Work-Related Musculoskeletal Disorders Among Surgeons and Interventionalists: A Systematic Review and Meta-analysis. *JAMA Surg.* 2018;153(2):e174947.
21. de Jesus Júnior LC, Tedesco TK, Macedo MC, Agra CM, Mello-Moura AC, Morimoto S. A self-report joint damage and musculoskeletal disorders data among dentists: a cross-sectional study. *Minerva Stomatol.* 2018;67(2):62-7.
22. Aldehailan KS, Alhubail FM, Almukhaimar SK, Wutayd HF, Alshehri RA, Almukhaimar NK, et al. Symptoms and Risk Factors of Carpal Tunnel Syndrome among Schoolteachers in Al-Ahsa, Saudi Arabia: A Cross-sectional Study. *Ann Afr Med.* 2024;23(3):429-36.
23. Chenna D, Madi M, Kumar M, Kumar V, Chopperla S, Tadikonda A, et al. Worldwide prevalence of carpal tunnel syndrome among dental health care personnel - A systematic review and meta-analysis. *F1000Res.* 2023;12:251.