REVIEW ARTICLE

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Risk factors for carpal tunnel syndrome

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Abstract

Introduction and Objective. Carpal tunnel syndrome (CTS) is a common condition characterized by the compression of the median nerve in the wrist. Left untreated, it leads to significant discomfort and loss of motor function in the hand. The aim of this systematic review is to identify and evaluate recent research on risk factors associated with CTS.

Review Methods. A systematic search of the PubMed/MEDLINE database was conducted, focusing on studies published within the last 5 years. The search strategy used relevant key words related to CTS and risk factors. Studies were included if they provided information on risk factors associated with CTS in the adult population. Review articles, systematic reviews and meta-analyses were excluded.

Brief description of the state of knowledge. Risk factors for CTS include repetitive hand movements in occupations that require typing, certain anatomical and physiological characteristics (e.g., smaller carpal tunnel size), age (risk increases with age), gender (higher risk in women), pregnancy, medical conditions (e.g., obesity, diabetes, arthritis, metabolic syndrome), and previous trauma or injury to the wrist. On-going research continues to shed light on the subject.

Summary. The systematic review found that physical labour, working in pain, and certain co-morbidities were strongly associated with an increased risk of developing CTS. Occupations such as grocery store workers, hairdressers, telephone operators and manual labourers (blue-collar workers) showed a significant association with the development of CTS, compared to the general population. Further studies are needed to investigate the potential impact of bilateral ovarian resection and alcohol consumption as risk factors. These findings underscore the importance of considering occupational factors and co-morbidities when assessing the risk of CTS.

Key words

carpal tunnel syndrome, risk factor, compression neuropathy

INTRODUCTION

Carpal tunnel syndrome (CTS) is the most common peripheral nerve compression neuropathy, accounting for 90% of all neuropathies [1]. It is a type of compression neuropathy caused by compression of the median nerve where it passes through the carpal tunnel. This syndrome is characterized by pain, numbness and tingling felt in the thumb, index finger, middle finger, and the radial side of the ring finger [2]. The pathophysiological causes of CTS include mechanical trauma, increased pressure and ischemic median nerve in the carpal tunnel [3]. CTS is generally a clinical diagnosis [4] based on the observation of characteristic subjective and physical symptoms. A complete examination of the entire upper limb, including the neck, shoulder, elbow and wrist, should be performed to exclude other causes. In specific cases, electrodiagnostic testing is helpful in the diagnosis of CTS. These examinations are used in determining severity and planning surgery. In addition, scientific data show that ultrasonography can be useful in the diagnosis of CTS [5]. Cases with severe symptoms are generally treated surgically, while conservative treatment is reserved for mild to moderate cases. Conservative treatments include splinting, certain oral drugs and injections, electrotherapy, particular manual techniques, and neural gliding exercises. Various combinations of the above can also be used [4]. Surgical treatment is generally based on opening the flexor retinaculum (FR) to fully decompress the nerve. There are currently two main surgical techniques. The first is open surgery, also known as conventional or mini-open. The second, is endoscopic treatment or videosurgery [6].

There are many risk factors for carpal tunnel syndrome described in the literature, and this review presents the most up-to-date of them.

MATERIALS AND METHOD

Based on the guidelines provided by the Primary Reporting Items for Systematic Reviews and Meta-Analyses Statement (PRISMA), the PubMed/MEDLINE database was used to identify potential articles for analysis using the following search terms: 'risk factor' and 'carpal tunnel syndrome'. The literature search was carried out on 1 May 2023 when studies from the last five years and with free access to the full content were selected. Review, systematic review, and meta-analysis studies were rejected. Inclusion criteria included risk factors for developing CTS. The exclusion criteria concerned studies describing mononeuropathy of other peripheral nerves and studies involving a person under 18 years of age [Fig. 1].

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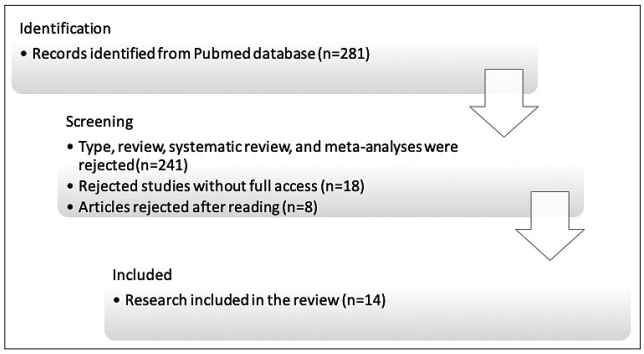

Figure 1. Study selection process

RESULTS AND DISCUSSION

Fourteen studies were included in the study and are used in this systematic review. Table 1 contains included studies with a brief description of the type of study and information on the number of cases.

Table 1. Included studies with a brief description of methods and results of studies

Studies	Brief description of the methods and results of studies
Cardona, 2019	Prospective cohort study on a group of 1,201 workers
Möllestam, 2021	Case-control study based on 27,123 individuals
Jackson, 2018	Retrospective cohort study on a group of 139,336 workers
Feng, 2021	Cross-sectional study based on a 969 respondents
Erick, 2021	Cross-sectional study based on a 165 respondents
Wiberg, 2021	Case-control study based on 12,312 individuals
Pourmemari, 2018	Cross-sectional study based on 6,256 participants
Sharief, 2018	Descriptive study based on 100 participants
Ulbrichtová, 2020	Case-control study with 462 individuals
Trybus, 2018	Case-control study based on 128 respondents
Leow, 2021	Retrospective study with cohort of 1,189 patients
Wang, 2020	Population-based cohort study on a group of 3,372 dialysis patients
Yeh, 2020	Retrospective study based on 2,908 participants
Starlinger, 2021	Population-based cohort study on a group of 3,306 women

Type of work. A lot of evidence can be found regarding the relationship between CTS and the type of work performed. The findings of Cardona et al. surprisingly suggest that high biomechanical exposures may actually be protective and lead to faster improvement in working populations [7]. In contrast to Cardona's conclusions, Möllestam et al., who classified the two types of work as 'blue-collar' or 'white-collar' worker based on the Swedish Standard Classification of Occupations (SSYK 96), found the opposite conclusion. 'Blue-collar worker' refers to people who engage in hard manual labour, as opposed to the 'white-collar worker' who do not have physically demanding jobs. They found that a significantly higher percentage of women (52%) and men (65%) with CTS were blue-collar workers, compared to their counterparts in the general population (40% and 46% respectively). The proportion of men and women with CTS who performed heavy manual labour was also higher than in the general population (6% and 48% respectively, compared to 4% and 31%). The odds ratio for CTS was 1.67 among blue-collar workers compared to white-collar workers, and increased with the level of manual labour performed [8].

The information revealed by Jackson et al. dhows that certain businesses and occupations are related to higher rates of CTS. Among the 20 businesses with the most noteworthy rates of CTS, three had rates roughly six times the normal rate, with textile, fabric finishing, and coating mills having a rate of 44.9 cases per 10,000 full-time specialists. The biggest numbers of CTS claims were in public administration (8,713 cases), insurance carriers (4,836), grocery stores (4,630), wired and wireless communication (3,412), and employment services (2,763). The occupation categories with the most elevated CTS rates were production (14.0), material moving (13.4), and office and administrative support (13.0), with telephone operators having the most elevated rate at 90.3 cases per 10,000 full-time workers [9].

In a study by Feng et al., working in pain was significantly associated with elevated odds of clinically confirmed CTS. The questionnaire option marked by participants as 'often or always working in pain' was significantly associated with an increased likelihood of clinically confirmed CTS (adjusted OR: 3.94 (95% CI 1.06 to 14.64) and 4.73 (95% CI 1.16 to 19.29) [10]. The study by Patience et al. found significant associations between several work-related factors and reporting CTS symptoms among hairstylists. Notably, there was a significant association between work experience (above 10 years) and reports of CTS symptoms. Also, between reports of CTS symptoms and awkward posture, types of used tools (higher prevalence when hair dryer, hair clipper ($p<0.001$), and hair iron ($p<0.005$) were used), and heavy workload. The hairstylists who reported that their work was stressful also had symptoms of CTS more frequently. In addition, those who washed customers' hair more often were nearly three times more likely to develop CTS symptoms than those who did not (OR 2.88, 95% CI: 1:41–5:85) [11].

Age. Older Higher age is associated with a higher risk of developing carpal tunnel syndrome, as confirmed by numerous studies. In a study by Erick et al., the average age of the participating subjects (M±SD) was 35.05±7.54 years, with an age range of 22–63 years. The analysis showed that people aged 31–40 and >40 complained of having CTS symptoms 9.84 and 14.92 times more likely, compared to those aged 20–30, suggesting that older age raises the risk of CTS symptoms, compared to the younger age group [11].

Other studies also show that age is identified as a risk factor for CTS. The study by Pourmemari et al. shows that age affects the risk of CTS, as it occurred more than twice as often in the 40–49 age group (HR 2.5, 95% CI: 1.7–3.8), compared to other age ranges [8].

Studies also confirm that the incidence of CTS is highest in patients over the age of 40, however, with a bimodal increase in the late 50s and late 70s. In this cohort, the incidence of CTS in the UK Biobank is 3.1%, which may roughly correspond to the incidence for clinically tested CTS (3.8%) obtained from one of the largest studies of CTS incidence [9].

Gender. In gender-specific analyses, female gender is a predictor of CTS symptoms. The information revealed by Erick et al. in their study indicate that, compared to men, women are 10 times more likely to have symptoms associated with CTS (OR of 9.99, and the 95% CI: 3.64–27.44). Women

constituted the majority (N = 92.56%) of those who took part in the survey, a total of 165 [7].

Similar conclusions can be drawn from other studies in which female gender was positively associated with the incidence of CTS. This is shown in the Pourmemari et al. study where the authors indicate that in women, compared to men, procedures are performed twice as often. The incidence of CTR ranged from 1.8%-2.6% in women and 0.7%-1.2% in men. The frequency of CTR ranged from 0.5–4.8 per 1,000 person-years in women, and 0.1–1.9 per 1,000 person-years in men. about 1.9% of men and 4.1% of women undergo surgical treatment for CTS [13]. Wiberg et al. conducted a study, one of the purposes of which was to generate a female-to-male prevalence ratio for CTS. The final number of respondents was 401,656 (184,499 men, 217,157 women) with white British ancestry. The gender of the respondents was defined on the basis of genotypic. The incidence in women was 3.9% and in men 2.0%, which was 1.95:1. The result agrees with those from previous studies in which the estimated scores were 1.4:1, 2:1, 2.9:1 and 3.6:1. This reveals the contribution of gender as a risk factor for CTS [12].

Body mass index (BMI). There is a great deal of evidence showing a link between the occurrence of CTS and elevated BMI. The information revealed by Sharief et al. shows that there is a correlation between BMI and the incidence of CTS, this is due to the fact that fat tissue accumulates within the carpal tunnel, or to the increase in hydrostatic pressure inside the carpal tunnel in obese patients. The majority of patients who participated in a study to find factors related to patient satisfaction after median nerve decompression surgery in the carpal tunnel, had a higher BMI (29.0 ± 3.6 vs. 25.5 ± 3.9; p = 0.0028) [14]. Ulbrichtová et al. also indicate that higher BMI (OR = 1.05, 95% CI = 1.01–1.11) is one of the most significant factors associated with carpal tunnel syndrome, citing the same reasons as Shieff et al. [15]. In a study performed by Wiberg et al., patients with CTS syndrome had BMI > 2.0 kg/m2 greater than the control group for both men and women. Obese patients were more than twice as likely to develop CTS, and each one-unit increase in BMI increased the risk of CTS by 7.4% [12]. Similar conclusions are presented in the study by Trybus et al., who presented a correlation showing that more than 90% of women with CTS have BMI > 25.0 kg/m2. In this group 54.5% of females were considered overweight and 33.3% considered obese. For comparison in the control group, overweight and obesity were observed in 31.0% and 17.2% of cases, respectively. Female patients with CTS had a significantly higher BMI than women in the control group (29.8 ± 5.0 vs. 25.7 ± 5.3 kg/m2; p < 0.001) [16].

Arterial hypertension. A study by Ulbrichtová et al. showed that BMI and arterial hypertension (OR = 4.63, 95% CI = 2.88–7.44) were the only predictors strongly associated with carpal tunel syndrome. Of the 162 CTS patients participating in the study, 79% of them mentioned hypertension as a chronic disease from which they suffered [15].

Thyroid diseases. Three publications identified thyroid disease as a risk factor for CTS [12,17]. A cohort study by Wiberg identified 24,558 patients out of 401,656 with hypothyroidism; moreover, hypothyroidism had a positive association with CTS OR 1.47 (95% CI 1.38–1.57) [12]. Jun Min Leow et al. found that 7.8% of participants who developed acute carpal tunnel syndrome complicating a fracture of the distal radius, had thyroid disease [17]. And research conducted by Wang and al. discovered that patients with end-stage renal disease after a parathyroidectomy were 1.7 times more likely to develop CTS than patients who did not undergo the operation [18].

Diabetes mellitis. Diabetes is often described in the literature as a risk factor for developing CTS, and diabetes is known to cause peripheral neuropathy and peripheral oedema. Kuang-Ting Yeh et al. found that after fracture of the distal radius, diabetic patients experienced CTS as a complication within nine months of the incident [19]. Research by Wiberg confirmed a strong positive association of diabetes with CTS with OR 2.31 (95% CI 2.17–2.46). Within the chosen cohort of 401,656, 24,558 were identified as having diabetes – 6.2% of participants [12].

Others. In a study by Patience Erick et al., alcohol abuse was also described as a risk factor. A group of hairdressers (165 people) were given a questionnaire that included a question about alcohol consumption. The results distinguished three groups, from which the percentage of people with CTS symptoms was calculated: those who do not consume alcohol – 13%, used to drink alcohol in the past, but currently do not drink – 53.8%, and still drinking – 44.8%. This factor has not yet been thoroughly studied, but there is a strong possibility that it contributes to the formation of CTS symptoms [11].

Julia Starlinger et al. investigated whether bilateral ovarian resection is a potential risk factor for CTS. They noted that of the 1,399 women with bilateral ovarian removal, 104 showed symptoms of CTS (9.4%), while in a reference group of 1,478 women, such symptoms occurred in 62 (5.4%). It is not known whether this correlation was due to other confounding factors, but is worthy of attention and observations in this direction should be expanded [20].

A study by Wiberg et al. examined the OR of CTS development in RA patients, which proved to be 2.7. However, they noted that disease development in this cohort may be associated with increased BMI; therefore, they accounted for this relationship and the OR dropped to 2.43. Nevertheless, they indicate RA as a significant risk factor for CTS [12].

Fractures of the radius bone also contribute to CTS. In the study by Jun Min Lew et al., 1,189 patients with radius bone fracture were followed-up over a year. Among them, 51 patients developed symptoms of CTS. A high percentage of complicated ACTS was shown after AO-OTA type C fractures [17].

Jie-Sian Wang et al. investigated whether parathyroidectomy in patients with end-stage renal disease would prove to be a risk factor for CTS. The study involved two cohorts of 1,686 patients each. One included patients who had had their parathyroid glands removed, and the other included patients without pneumothorax (PTX). Of the two groups, CTS symptoms appeared in 116 patients, 69 patients in the first group (with PTX) and 47 patients in the second group (without PTX). The results of the study indicate that the first group (with PTX), after accounting for other risk factors, had a 1.7-fold increased risk of CTS relative to the second group without PTX [18].

Limitations of the Review. The limitations of the this systemic review are mainly due to the relatively small number

of studies included in the review, although the assumption was to include only the latest research. Carpal tunnel syndrome is the most common peripheral nerve compression nephropathy, and although the number of studies available is vast, but most of them are old papers. The published studies are of good quality and are based on a very large group of cases.

SUMMARY

Based on the review, it can be concluded that the type of work performed, particularly manual labour, was strongly associated with an increased risk of CTS. Analyses included grocery store workers, hairdressers, telephone operators, public administration workers and blue-collar workers. In addition, working in pain was associated with an increased likelihood of clinically confirmed CTS. The strongest independent variables were older age and female gender, which, in conjunction with the type of work performed, appear to be the most important predictors of CTS.

The results showed a correlation between elevated BMI and the prevalence of the subjects' complaints. A significant proportion of those reporting CTS symptoms reported a history of co-morbidities, such as hypertension, diabetes, and thyroid disease. Other important predictive factors included patients with RA, those who had undergone parathyroidectomy, and those who had undergone radial bone fracture. Bilateral ovarian resection and alcohol consumption were also noteworthy risk factors, but have not yet been thoroughly investigated. However, there is a strong possibility that they contribute to CTS symptoms, indicating that observations in this direction should be expanded.

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