

# Carpal Tunnel Syndrome and use of computer keyboard and mouse; a systematic review

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## ABSTRACT

**Introduction:** Carpal Tunnel Syndrome is neuropathy of median nerve due to its compression in carpal tunnel. Some of the professionals like computer users are at a high risk of developing this condition. However, limited high quality evidence in the form of systemic reviews may be found in the literature. This systematic review was carried out to evaluate review evidence related to carpal tunnel syndrome in computer users.

**Materials & Methods:** Review of the literature regarding Carpal Tunnel Syndrome was carried out using databases PubMed, Google scholar, Medline and CINAHL. Articles published in English until December 2017 were included in this review. Key words including 'Carpal Tunnel Syndrome' or 'CTS' and 'Computer Operators' or 'Computer Users' were used for searching relevant literature.

**Results:** A total of 8 studies were identified and were included in this systematic review. Most of the studies (n=6) showed positive association between CTS and computer use. Abnormal flexion-extension posture of wrist joint, repetitive movements throughout the day and use of vibratory items were suggested as potential causes for the development of CTS.

**Conclusion:** Based on the included literature, it is concluded that prolonged use of keyboard and mouse are the some of the major contributing factors for the development of CTS. Moreover, any activity involving abnormal positioning of wrist joint leads to an increased CT pressure which might increase the risk of developing CTS.

**Keywords:** Carpal Tunnel Syndrome, median never, computer keyboard users

The authors declared no conflict of interest and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All authors contributed substantially to the planning of research, questionnaire design and write-up of the review.

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## INTRODUCTION

Carpal Tunnel Syndrome (CTS) is a neuropathy of median nerve due to its compression in carpal tunnel.<sup>1</sup> Median nerve compression results into pain, numbness and tingling sensation on the volar surface of the hand.<sup>2</sup> CTS is one of the commonest compression neuropathy in both males and females. The prevalence of CTS in general population is reported as 3-5.8% in females and 0.6-2.0% in males. The major contributing factors for CTS development included diabetes mellitus, rheumatoid arthritis, acromegaly, hypothyroidism, trauma to wrist joint, pregnancy and tenosynovitis.<sup>3,4</sup> The incidence of CTS is associated with the vibrating instruments used in offices and industries.<sup>5,6</sup> Among the office workers, the typing requires repetitive movement of wrist joint, which sometimes adopt varying postures that can lead to an increased risk of CTS.<sup>7-9</sup> There is a contradiction found in studies regarding the association of CTS with position of the wrist joint, which is reflected in the work of Silverstein et al suggesting that excessive flexion-extension posture are not responsible in the incident of CTS.<sup>10</sup> Whereas, Vikari-Juntura and Silverstein reported significant association between awkward postures of the wrist joint and risk of CTS development.<sup>11</sup> It has been reported that CTS is the common musculoskeletal problem in people using computer in their daily routine.<sup>5</sup> During the prolong use of

computer mouse, the wrist joint remains in awkward position of extension ranging 23° to 30° and ulnar deviation which remains deviated from 3.2° to 5.2°. Moreover, wrist position while using computer keyboard remains extended from 140 to 200, making an individual prone to develop CTS. Gerr et al. observed wrist posture among 379 computer users and found that mean wrist extension had remained 24.3° during keyboard use and 23° during the use of mouse. Moreover, mean ulnar deviation reported was 5.0° during keyboard use and 1.0° during mouse use. Significant association was found among the development of CTS and workers using computer for more than 20 h/w.<sup>1</sup>

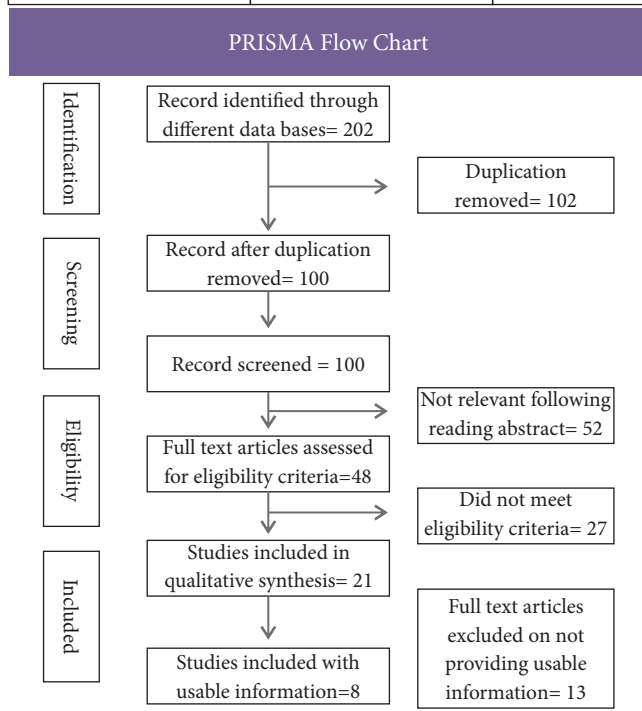
In the recent years, it remained a matter of great concern that the massive use of computer can cause CTS and it is important to categorize the condition as occupational hazard.<sup>3</sup> This review was intended to evaluate the existing epidemiological evidence regarding CTS in computer users. Because of some similarities between repetitive activities in computer work and low force work, studies examining association between repetitive work and CTS were discussed also. In order to determine possible pathophysiological mechanisms, studies of median nerve function among computer users, exposure characteristics in computer work and influence on carpal tunnel pressure and median nerve function were also evaluated.

**MATERIALS & METHODS**

To identify publications, a search was made in Pub Med, Google scholar, NCBI, Medline and CINAHL. Epidemiological studies examining associations between computer work and CTS were searched using keywords Carpal Tunnel Syndrome OR CTS AND Computer Operators OR Computer Users. Articles published in English language from 2000 to 2017 were included. Please see table 1 for the results while using the key searches in different databases.

Table 1: Table showing searches

Search Engine	Search Items	Results
Google Scholar	CTS IN CO	3740
	CTS AND CO	3740
	CTS OR CO	3490
PUB MED	CTS In CO	7
	CT AND CO	7
	CTS OR CO	4817
Medline		7
NCBI	CTS AND CO	95
	CTS IN CO	95



**RESULTS**

A total of 202 articles were identified through different databases using different key words in the selected data bases. Out of 202 articles, 102 articles were duplicates and were not considered, leaving 100 eligible articles for this systematic review. The authors read the remaining 100 articles and 52 articles were not relevant to the review. Full text articles of the remaining 48 manuscripts were checked for eligibility criteria and 27 did not meet the eligibility

criteria. Studies included in qualitative synthesis were 21. While, 13 studies were excluded by not providing usable information and leaving a total of 8 articles eligible for this review.

It has been reported that the overall prevalence of CTS is 3.0-5.8% among women and 0.6-2.1% among men in general population.<sup>3, 12, 13</sup> In the United State, within the past decade the prevalence of musculoskeletal disorder was increased to 65% of overall reported occupational illnesses.<sup>14</sup> A study conducted on 1995 participants, where a total of 92,576 injuries were reported in individuals working with keyboard and mouse, reported a strong association with the incident of CTS and computer use. According to a systematic review by Thomson et al. prevalence of CTS remained 1.1% in dominant hand and 0.3% in non-dominant hand.<sup>3</sup> CTS was diagnosed on the basis of its signs and symptoms, neurological studies and test in most of the included studies in this systematic review. However, the exact diagnostic criteria remained unclear in these studies. Chin et al reported that larger the wrist angle while doing any sort of typing activity on keyboard could increase the risk of developing CTS. Moreover, wrist angle extension of greater than 20° was associated with the development of CTS in patients.

Ali et al reported CTS development in those computer users who used to work for many hours in front of computers.<sup>6</sup> In a meta-analysis by Doohee et al where 9 studies were analyzed, it was found that malposition of wrist angle increases with the increasing use of computers per day, which in turn produces risk of CTS. In the later meta-analysis, studies where self-reported outcome measures were used, included in this review and studies with no objective measure were excluded.<sup>7</sup> Some of the included studies carried out on the prevalence of CTS in computer users focused on the wrist posture while working on computer. The mechanism of developing CTS is explained Ghasemi-rad et al in a review. According to the aforementioned study, the intra CT pressure is about 3-5 mmHg in healthy individuals during the neutral position of wrist. If blood supply to the region is impaired, the CT pressure approaches or exceeded 20-30 mmHg, exposing an individual to develop CTS. During the use of computer mouse without mouse pad wrist extension angles increases which results in increasing the CT pressure up to 16-21 mmHg and the risk of developing CTS increases many folds.<sup>15</sup>

Atroushi et al. conducted a large population-based study. They included both physical examination and nerve conduction study for diagnosis purposes. It is evident from this study that using key board for prolong period of time have significant effects on developing CTS and the prevalence of CTS increased with the increase in working hours/day. The study was conducted vary cautiously with sufficient blinding of the interviewer regarding exposure and of the technician regarding the symptoms status 16. Stevens et al. conducted a population-based study in which all the participants were carefully identified as regular computer users. They compared the exposure and demographic characteristics between the two groups. Stevens observed that computer use per hour/day and years with key board use did not differ between the two groups. Although regular mouse use was present in CTS group (48.1%) than non CTS group (27.9%).<sup>17</sup> Gerr et al. conducted an extensive prospective study in computer

users. Analyses of this study suggested that there was no association between CTS and computer use. By using the outcome definition and by including both symptoms and NCT results the prevalence and incidence was recorded low in the working population.<sup>18</sup>

In the systematic review of Palmer, 38 primary reports were reviewed, with the study based on the evaluation of physical activities in the job. The review reported that performing repetitive flexion extension activities of wrist joint double the risk of development of CTS.<sup>19</sup>

## DISCUSSION

This systematic review had found evidence for an association between non neutral wrist position in extension. The overall risk for CTS was two times higher in computer users exposed to non-neutral or extended wrist positions during mouse and key board work.

A study conducted by Lieu et al reported that the severity of clinical symptoms was well-matched with nerve conduction study and also observed a significant correlation was found between wrist extension posture and CTS development. Lieu et al reported that wrist extension angle more than 20° is greater risk of developing CTS.

Ali in his study described that wrist posture in non-neutral position i.e. in flexion or extension for longer period had higher risk for developing CTS. Using mouse and key board with wrist angles deviation i.e. prolong flexion and extension are the higher risk and potential cause for CTS.<sup>6</sup>

In the Meta-analysis of Doohee et al significant association was reported between wrist posture and carpal tunnel syndrome among different workers. Moreover, it was found that the cause of CTS development is prolong exposure to non-neutral positions of flexion or extension. Due to prolong wrist angle deviation/ non neutral wrist posture i.e. flexion or extension increases the risk of CTS 2 fold.<sup>7</sup>

Ghasemi-rad et al reported in a systematic review that in normal

healthy individuals, the intra carpal tunnel pressure is about 3-5 mmHg. When the wrist angles are deviated or when the wrist is in non-neutral position then the CT pressure approaches or exceeds 20-30 mmHg which interrupts the blood flow of median nerve.

While using computer mouse, the wrist posture is in extension resulting in raising the CT pressure to 16 to 21 mmHg and while using mouse to point and click increases the CT pressure to 28 to 33 mmHg, hence causes CTS.<sup>15</sup>

In the large population-based study by Atroshi et al. which included both physical examination and NCT for diagnoses, an association was reported between keyboard use and CTS. The prevalence of CTS increased with working hours/day. The study was conducted carefully with satisfactory blinding of the interviewer about exposure and of the technician regarding the symptoms status.<sup>16</sup>

Stevens et al. conducted population based study which showed statistically significant and positive association between mouse use and the developing of CTS.<sup>17</sup>

While the study of Gerr et al. found that the CTS prevalence was too low to allow analysis of association between CTS and computer use. However, it is important to note that Gerr et al reported that with the use of an outcome definition including both symptoms and NCT the prevalence and incidence of the disease was low in the working population.<sup>18</sup>

Palmer summarized 38 primary reports for systematic review. The study analysis was based on evaluation of job titles and physical activities in the job. Results of the review reported that the frequent and regular use of vibratory tools and the wrist angle in non-neutral position for prolonged period of time increases the risk of CTS >2fold.<sup>19</sup>

## CONCLUSION

Based on the included literature, it is concluded that prolonged use of keyboard and mouse are some of the major contributing factors for the development of CTS. Moreover, any activity involving abnormal positioning of wrist joint leads to an increased CT pressure which might increase the risk of developing CTS.

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