

## Working Experience and Smoker Workers Impact on Carpal Tunnel Syndrome (CTS)

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**Abstract :** Carpal Tunnel Syndrome(CTS) is a symptomatic compression neuropathy of the median nerve at the level of the wrist/hand characterized physiologically by evidence of increased pressure within the carpal tunnel and decreased function of the nerve at that level. The objective of this paper is to study the probability of occurrences of Carpal tunnel syndrome of the workers engaged in smoking. The study is conducted on 98 workers comprising of all men and is focused on studying the impact of working experience and smoker workers in industries. Chi-square test is used.

**Keywords:** CTS, Chi-square test, median nerve, smokers, wrist

### I. Introduction

#### 1.1 ERGONOMICS

Ergonomics is the science of designing the job, equipment, and workplace to fit the worker and work environment to suit the capabilities of the workforce whereby it involves matching the task to the worker, rather than attempting to fit the worker to the task/job [1]. Many occupational accidents, injuries, diseases and Musculoskeletal disorders (MSDs) continue to arise due to a lack of ergonomics, repetitive and forceful work in the workplace, and there is a need to quantitatively assess exposure of individuals to MSDs [2]. This leads to workplace hazards, poor workers' health, mechanical equipment injuries, disabilities, and in turn reduces worker productivity and product/work quality, and increases cost.

#### 1.2 CTS AND ITS WORK-RELATEDNESS

CTS are divided into acute and chronic depending on its relative duration to develop symptoms from nerve conduction abnormality. The acute case is relatively rare and developed within a short period due to acute compression to the median nerve followed by the abnormal clinical conditions: spontaneous bleeding in hemophiliacs, persistent thrombosis of the median artery, dislocation of the carpal tunnel base, infections, fractures, or during pregnancy [3]. On the other hand, the chronic case induces such pathophysiological changes at the hand and wrist as nerve impairment. If the case is work-related, the compensation system will redeem all costs accompanied to treatment and lost salaries. However, no clear quantitative dose-response relationship between occupational risk factors and CTS prevalence has been yet established. NIOSH provides a set of criteria, including clinical symptoms, objective signs, and evidence of work-relatedness as practical guidelines to define a case of work-related CTS as shown in Table 1. If a person reports one or more of symptoms and he/she shows a positive clinical diagnosis result, he/she is considered as CTS patients [4]. Moreover, if the patient involved a job with one or more of ergonomic hazards, then the case is determined as work-related CTS.

Table 1. NIOSH Case Definition Criteria For Work-related CTS

Criteria	Descriptions
Symptoms	A patient reports one or more of the following symptoms in the hand:- pain, numbness, paresthesias (tingling sensation), hypoesthesia (loss of sensation).
Clinical diagnosis	The patients should show a positive result either in:- physical provocative tests (Tinel's test and Phalen's maneuver), nerve conduction test.
Evidence of work relatedness	The patients should involve a job with one or more of the following ergonomic hazards: repetitive and/or prolonged motions of the hand, forceful exertions by the hand including pinching or gripping, sustained awkward wrist postures, excessive vibration transmitting of the hand, localized mechanical pressure.

#### 1.3 OCCUPATIONAL RISK FACTORS CTS

Activities associated with the development of CTS may arise from ordinary movements that include repetitive activities such as gripping and reaching. These movements may become hazardous without sufficient rest or recovery time. The major risk factors include; forceful exertion, repetitive motions, awkward postures, localized contact stresses. These risk factors are classified largely into two groups: occupational (physical)

factors consisting of task and environmental conditions, and other are personal factors including age, gender, anthropometric factors and medical history [5] .

Numerous studies identified the repetitive motions as a risk factor associated with development of CTS Many workers perform the same tasks and stereotyped motions over and over, sometimes thousands or tens of thousands time each day [6]. Highly repetitive motions require fast muscle contractions, which become less efficient and demand greater recovery time because muscle capacity to produce force diminishes with increasing contraction speed.

### 1.4 RECOGNITION OF CTS

Victims of CTS often consult a doctor. The evaluation of occupational CTS includes identifying workplace risks. Evaluation begins with a discussion of the victims' employment and requires a detailed description of all the processes involved in a typical day's work. It also requires consideration of the frequency, intensity, duration and regularity of each task performed at work. Diagnosis of CTS is confirmed by performing certain tests to detect damage to the median nerve [7].

- i. Tinel's test- The physician taps the median nerve at the wrist. A tingling response in one or more fingers indicates damage to the median nerve.
- ii. Phalen's test - The patient puts the backs of the hands together and bends the wrists for one minute. Tingling of the fingers indicates damage to the median nerve.
- iii. Electromyography- Electrodes are placed on the forearm and electrical current is passed through the patient. Measurements on how fast and how well the median nerve transmits messages to muscle indicate, if there is damage to this nerve.

## II. Experimentation

In this paper consists of 98 manual manufacturing workers. Health surveillance was designed according to the information required like age, height, weight, duration of job, levels of potential symptoms to study the prevalence of potential CTS symptoms amongst manufacturing workers [8]. Also the standardized health surveillance guidelines were used to authenticate the design considered in present study by experts from industry and medical profession.

Job categorization is done according to level of repetition (per sec), force involved (kg), BMI (kg/m<sup>2</sup>) of the workers. The participants ranged in age from 24 to 60 years with a mean of 47.9 (SD 9.15) years (Table 2). The mean body mass index (BMI; kg/m<sup>2</sup>) of the participants of this study was 24.6 kg/m<sup>2</sup> (SD3.72), and it ranged from 17.2 kg/m<sup>2</sup> to 37.9 kg/m<sup>2</sup>. The workers had been performing work for a mean of 24.6 years (SD 8.2).

Table 2. Baseline characteristics of workers

Factor of concern	Number of workers	Age (years)	Weight (kg)	Height (feet)	BMI(kg/m <sup>2</sup> )	Employment time at present site (years)
Statistics	98	47.9±9.15	67.5±9.29	5.625±0.219	23.1 ± 3.72	24.6 ± 8.12

### 2.1 IMPACT OF WORKING EXPERIENCE ON CTS USING CHI-SQUARE TEST

The primary occupational risk factors of CTS include repetition, forceful hand exertions, and deviated wrist postures, lack of rest and recovery, and vibration [9]. Workers in railway workshop use to do repetitive and forceful work i.e. fitting of locomotive parts, welding, Painting and hammering jobs and does the same work for a number of years so an attempt has been made to establish the relationship of working experiences and potential CTS symptoms with the help of statistical tools i.e. Chi-Square Test [10].

To study the impact of potential CTS symptoms on work experience, raw data from health surveillance in manufacturing industry workers has been classified according to duration of job/tenure in year as shown in Table 3 [11]. As trend in literature shows that due to repetitive and forceful work occupation injuries and illness occurs in males of 24- 35 years of with 1-6 month of working experience.

A hypothesis is assumed that the number of work experience does not affect the occurrence of potential CTS symptoms. The data is divided into two groups i.e. (i) workers having less than 25years work experience (level 1) and (ii) workers having more than 25 year work experience (level 2). Basis of this classification is that the average life long experience of workers may be an average of 40- 50 years.

Now, to check that what is the effect of work experience of potential CTS symptoms raw data which is taken from the Surveillance form on the basis of exposure level is shown in a  $2 \times 2$  contingency Table 3.

Table 3. Exposure level based ( $2 \times 2$ ) contingency table of workers for chi square test

Symptom	Level 1	Level 2
CTS sufferers	12	26
Non CTS sufferers	17	43

Calculation of Observed, expected and  $\chi^2$  calculations have been shown in table 4, 5 and 6

Table 4. Survey based observed frequency data for Smokers and Non- Smokers.

	Level 1	Level 2	Total
Row 1	12	26	38
Row 2	17	43	70
Total	29	69	98

Table 5. Expected frequencies for Smokers and Non- Smokers

	Column 1	Column 2	Total
Row 1	$E1=38 \times 29 / 98 = 11.245$	$E2=38 \times 69 / 98 = 26.755$	38
Row 2	$E3=70 \times 29 / 98 = 20.715$	$E4=70 \times 69 / 98 = 49.285$	70
Total	29	69	98

Table 6. Calculated  $\chi^2$  values of Smokers and Non- Smokers

Fo	Ft	$(fo - ft)^2$	$(fo - ft)^2 / ft$
12	11.245	0.3136	0.051
26	26.755	0.3025	0.021
17	20.715	11.08	0.667
43	49.285	43.56	0.801

Calculated  $\chi^2 = \sum (fo - ft)^2 / ft = 1.54$

The number of degrees of freedom is required in order to apply the Chi Square Test. In a ( $2 \times 2$ ) contingency table 3.6, the degrees of freedom  $v = (2-1) (2-1) = 1$ . In general, for r rows and c columns, the number of degrees of freedom is  $(r-1) (c-1)$ .

The standard value for degree of freedom 1 at 5% level is 3.84. Since the calculated value is 1.54 of  $\chi^2$  is less than the standard value (3.84), the hypothesis is accepted. Hence, the number of work experience does not affect the occurrence of potential CTS symptoms. It means that working experience does not affect the occurrence of potential CTS symptoms. The reason that would explain this relationship between the working experience and CTS symptoms is not well understood.

## 2.2 IMPACT OF SMOKER WORKERS ON CTS USING CHI-SQUARE TEST

Smoking which may contribute to CTS by affecting the blood flow to the median nerve. CTS is an illness, not an injury, and health factors such as obesity, smoking, heavy alcohol consumption, diabetes, and thyroid disease are much more likely to contribute substantially to the onset of CTS than workplace activities. It indicates smoking may affect the occurrence of potential CTS symptoms [12]. To study the impact of potential CTS symptoms on smoker's workers in industry, Raw data from health surveillance in manufacturing industry workers is classified according to category of as shown in Table 8. Smokers and non-smokers and potential CTS sufferers [13].

A hypothesis is assumed that the smoking habit does not affect the occurrence of potential CTS symptoms. The data has been divided into two groups i.e. smokers (level 1) and another non-smoker (level 2)

Table 7. A (2 × 2) contingency table set-up used for Chi Square test

Description	Level 1	Level	Total
Symptom Present (Test positive)	a	b	a + b
Symptom not Present (Test negative)	c	d	c + d
Totals	a + c	b + d	a + b + c + d = n

Table 8. Exposure level based (2 × 2) contingency table of Smokers for chi square test

Symptom	Smokers	Non-smokers
CTS sufferers	29	25
Non CTS sufferers	13	31

Observed, expected and  $\chi^2$  calculations have been shown in table 9, 10 and 11.

Table 9. Survey based observed frequency data for Smokers and Non- Smokers.

	Column 1	Column 2	Total
Row 1	29	25	54
Row 2	13	31	44
Total	42	56	98

Table 10. Expected frequencies for Smokers and Non- Smokers

	Column 1	Column 2	Total
Row 1	$E_1=54 \times 42 / 98 = 23.14$	$E_2=54 \times 56 / 98 = 30.86$	54
Row 2	$E_3=44 \times 42 / 98 = 18.86$	$E_4=44 \times 56 / 98 = 25.14$	44
Total	42	56	98

Table 11. Calculated  $\chi^2$  values of Smokers and Non- Smokers workers

Fo	ft	(fo- ft) <sup>2</sup>	(fo- ft) <sup>2</sup> /ft
29	23.14	34.34	1.48
25	30.86	34.34	1.11
13	18.86	34.34	1.82
31	25.14	34.34	1.36

Calculated  $\chi^2$  for wrist pain =  $\Sigma (fo- ft)^2 / ft = 5.77$

The number of degrees of freedom is required in order to apply the Chi Square Test. In a (2 x 2) contingency Table 3.6, the degrees of freedom  $v = (2-1) (2-1) = 1$ . In general, for r rows and c columns, the number of degrees of freedom is (r-1) (c-1).

The standard value for degree of freedom 1 at 5% level is 3.84. Since the calculated value is 5.77 of  $\chi^2$  is greater than the standard value (3.84), the hypothesis is rejected hence the probability of having CTS is more amongst Smokers. It means that smoking may be one of the risk factors, which helps in contribution of the occurrence of potential CTS symptoms.

### III CONCLUSION

. In this paper work effect of Repetitive hand movements and forceful work has been studied on human body in terms of potential CTS symptoms. Chi-square test is used to achieve the objectives. Following conclusions have been made from this dissertation:

- Chi square test results revealed that working experience does not affect the occurrence of potential CTS symptoms
- Chi square test results revealed that smokers are more prone to potential CTS symptoms than that of non-smokers

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