

Estimation of Carpal Tunnel Syndrome (CTS) Prevalence in Adult Population in Western European Countries: A Systematic Review

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Abstract: Carpal Tunnel Syndrome or CTS has been recognized as an occupational disease in 9 out of 12 member countries of the EU as early as 2001. CTS is ranked 6th among the occupational diseases in Scandinavian countries and also outside EU. Increased prevalence of the disease is believed to have a link with several occupations where work involves exposure to high force and pressure and repetitive work using vibrating tools. Diabetic patients and pregnant women have a high prevalence rate of 30% and 20% consecutively. The aim of the study is to determine the prevalence of Carpal Tunnel Syndrome (CTS) in 27 member countries of Western European (EUR A) by identifying published papers with suitable data. This study used Preferred Reporting Items for Systematic Review and Meta Analysis (PRISMA) checklist for literature search, identification, data collection and evaluation of literatures to estimate prevalence of Carpal Tunnel Syndrome (CTS) in Adult Population in Western European Countries. Following the PRISMA protocol and guidelines for systematic review of quantitative literatures evaluation and tabulation of data was done. It has been confirmed through this study that Carpal Tunnel Syndrome remains as one of the most simple but frequently observed diseases among the adult population in this region. Despite high prevalence of CTS in this region any standard criteria for clinical diagnosis of this disease have not yet been established. There is also no consensus on whether CTS is a clinical or electro-physiologically diagnosed disease. But sufficient pathophysiological and epidemiological evidences are available for a causal relationship to be assumed between manual tasks and the occurrence of CTS. Industries can take actions to educate their workers about these work place safety practices to grow awareness against CTS. Furthermore, research to determine clear causal relation of CTS with occupation and to reach a consensus about the disease's diagnostic criteria is needed.

Keywords: Carpal Tunnel Syndrome, CTS, Carpal Tunnel Syndrome (CTS) Prevalence, Compressive Neuropathy, Occupational Health

1. Introduction

Carpal Tunnel Syndrome (CTS) is a compressive neuropathy, which is caused by entrapment of median nerve at the level of the carpal tunnel [1]. The condition can lead to decreased grip strength with atrophy and in severe cases can even result in permanent deterioration of muscle tissue and loss of hand function [2].

Increased prevalence of the disease is believed to have a link with several occupations where work involves exposure to high force and pressure and repetitive work using vibrating tools [3]. Diabetic patients and pregnant women have a high

prevalence of 30% and 20% consecutively [4].

CTS is the most frequent form of median nerve entrapment accounting for 3.8% of general and 90% of all entrapment neuropathies. It is amongst the highest reasons to be absent from work in UK accounting for a median number of 27 days a year. The surgical decompression rate is 43-74 per 100,000 of the affected population [3]. In USA one out of every twenty people suffer from CTS. Caucasians are more prone to CTS compared to other races [5].

CTS has been recognized as an occupational disease in 9 out of 12 member countries of the EU as early as 2001. In 2003 the European Union has listed CTS as an occupational

disease. CTS is ranked 6th among the occupational diseases in Scandinavian countries and also outside EU [6].

Prevalence rates are up to 9.2% in women and 6% in men. Evidenced to be more common in women than men and the occurrence is commonly bilateral with a peak age range of 40 to 60 years. In European countries over 60% of work related upper limb musculo-skeletal disorders identified are due to CTS. Some industries such as construction workers have higher prevalence of the disease reaching up to 73% [7]. The majority of the researchers have addressed the relation between Carpal Tunnel Syndrome and occupation but this causal relationship has been refuted by others [8].

The Western European region is categorized in 'Group A' by WHO as countries of cost effective interventions [9]. Being the region of mostly developed countries it still suffers from several musculo-skeletal diseases, a large portion of which is Carpal Tunnel Syndrome. Though the European Union recognized CTS as one of the major occupational diseases, the amount of data available remains less comprehensive than anticipated. Therefore, the aims of the study is to determine the prevalence of Carpal Tunnel Syndrome (CTS) in 27 member countries of Western European (EUR A) by identifying and revising published papers with suitable data.

2. Methods

2.1. Search Strategy

This study used the Preferred Reporting Items for Systematic Review and Meta Analysis (PRISMA) checklist for literature search, identification, data collection and evaluation of literatures to estimate prevalence of Carpal

Tunnel Syndrome (CTS) in Adult Population in Western European Countries. Following the PRISMA protocol and guidelines for the systematic review of quantitative literatures evaluation and tabulation of data has been conducted [10]. Relevant literature reporting prevalence of CTS among adult population in the selected region has been searched using PubMed and Web of Knowledge. Literature has been searched in PubMed using advanced search options title/abstract and search terms "Carpal Tunnel Syndrome" or "CTS" and "Western Europe" or specific country name. Such as, for Web of Knowledge literature the topic and address search terms used were "Carpal Tunnel Syndrome" or "CTS" and "Western Europe" or specific country name. Specific country name included all 27-member countries of Western Europe (EUR A) and was separated by Boolean operator 'OR' to narrow the search results. A manual search has also been carried out based on bibliographies of the identified published articles. References and cross-references of the identified articles were critically studied to identify any relevant studies missed in electronic or manual search process. Additionally the University of Edinburgh library has also been searched to retrieve full text of any unpublished or gray-literature.

2.2. Inclusion and Exclusion Criteria

This study included articles which reported- (i) quantitative outcome of data regarding Carpal Tunnel Syndrome in Western European countries, (ii) data about 15-65 year old population and (iii) articles published in English language. Articles reporting qualitative data, reporting data about surgical interventions and articles published in any other language than English have been excluded.

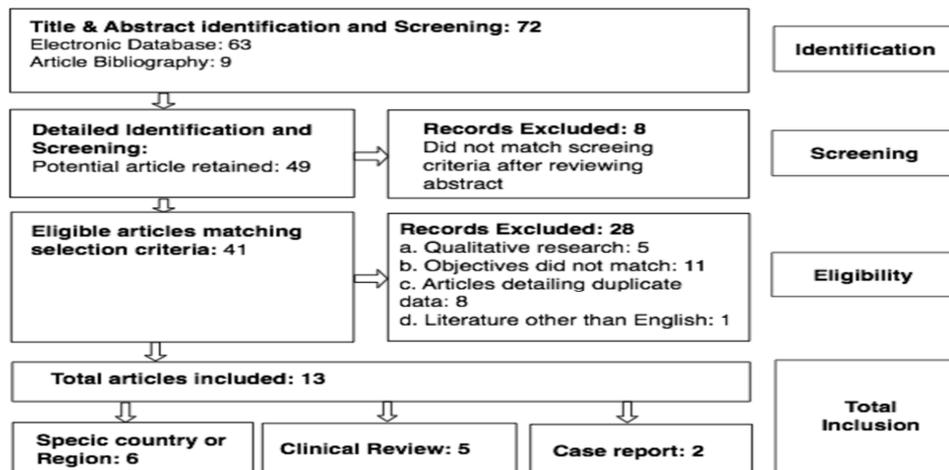


Figure 1. PRISMA flow diagram of the article screening process.

Where multiple studies for the same country (as for Italy, Finland and France) were available the most recent was included and the rest were excluded. The whole selection process has been displayed in Figure 1.

2.3. Quality Assessment

Articles were assessed on the basis of appropriateness and

clarity of the research objectives or aims of the study, study design, study location, data collection methods and study outcome. Each article identified through electronic or manual search, an initial thorough cross-examination of the title and abstract was done to make sure that selection criteria were met. If an article failed to adhere to selection criteria, full text article was not retrieved and it was excluded. At the end of

the quality assessment, the identified articles were categorised based on: (i) Study location and Study period, (ii) Study method & Sample size and (iii) Study outcome. A record of all excluded articles was preserved.

3. Results

The papers (a total of 72) obtained by the search strategy were first categorized by title of the paper. Screening of the abstract of suitable papers were then done to identify any suitable data regarding Carpal Tunnel Syndrome. Majority of the papers that were identified dealt with case description, diagnosis, treatment and outcome of the syndrome. Papers which include only special conditions (eg, pregnant women, elderly population etc.) or specific diseases (eg, diabetes, thyroid disease, trigger thumb, other musculo-skeletal diseases etc.) were excluded because of the potential of selection and inheritance bias and the effect they may have

on the whole result. Only papers, which discussed the prevalence of Carpal Tunnel Syndrome, were included. Reviews were appropriately analyzed and where possible original studies were sourced for inclusion. In situations where the original paper was not found or the presented paper was not in English, only the data presented in the review were included, as in the case of the article of Italy [11]. This study did not find any article published after 2003 which presented the prevalence of musculo-skeletal diseases specially Carpal Tunnel Syndrome in Western European countries. A total of 13 articles met the exclusion and inclusion criteria representing the data of 13 member countries of Western Europe. Among these articles 6 have reported prevalence of CTS in specific settings [11-16], 5 were clinical reviews [17-21] and 2 were case reports [22, 23]. Table 1 presents summary of all 12 studies reporting prevalence of Carpal Tunnel Syndrome among adult population in Western Europe.

Table 1. Summary of selected literatures.

Authors and Publication year	Country of study	Study type	Sample size	Study period
Bone et al., 2004 [12]	United Kingdom	Two stage Cross sectional study	6038	1998-2000
Bonfiglioli et al., 2005 [17]	Germany	Clinical review	106	2004
Cimmino et al., 2006 [11]	Italy	Case report	3695	1996
Carmona et al., 2003 [13]	Spain	Cross sectional study	788	1999-2000
Roquelaure et al., 2006 [22]	France	Surveillance study	2685	2002-03
Andersen et al., 2003 [18]	Denmark	Cohort study	9480	2000-01
Cook et al., 2001 [19]	Hungary	Clinical review	193	1999-2000
Miranda et al., 2010 [14]	Portugal	Clinical review	410496	2006
Atroshi et al., 1999 [15]	Sweden	Case-control study	2466	1997
Çalgüneri et al., 2006 [20]	Turkey	Clinical review	526	1988-2003
Krom et al., 1992 [16]	Netherlands	Clinical Review	715	1983-85
Shiri et al., 2007 [23]	Finland	Clinical review	6254	2000-01

Table 2. Summary of Case definition.

Country	Case definition
United Kingdom	Interrelation and impact of musculo-skeletal disorders of upper limb during time period among adults leading to inclusion in national surveillance data [12]
Germany	Diagnosis of symptoms and median nerve conduction values in workers performing repetitive jobs leading to inclusion in national surveillance data [17]
Italy	Diagnosis of musculo-skeletal conditions in patients referred to tertiary rheumatology centres leading to inclusion in national surveillance data [11]
Spain	Diagnosis of rheumatoid arthritis leading to inclusion in national surveillance data [13]
France	Diagnosis of upper extremity musculo-skeletal disorders in working population leading to inclusion in national surveillance data [22]
Denmark	Interrelation and impact of computer use and Carpal Tunnel Syndrome during time period [18]
Hungary	Diagnosis of musculo-skeletal disorders by hand symptoms and nerve conduction studies of the median nerve across the carpal tunnel among construction apprentices leading to inclusion in national surveillance data [19]
Portugal	Diagnosis of rheumatic occupational diseases leading to inclusion in national surveillance data [14]
Sweden	Diagnosis of CTS based on clinical examination in general population leading to inclusion in national surveillance data [15]
Turkey	Diagnosis of extra-articular manifestation of rheumatoid arthritis in a single hospital leading to inclusion in national surveillance data [20]
Netherlands	Cases taken from population register to study the value of brachialgia paraesthetica nocturna (BPN) in diagnosing CTS [16]
Finland	To diagnose hand dominance in upper extremity musculo-skeletal disorder [23]

All the selected articles reported prevalence rate either per 100000-person year or number of cases identified at national or regional level over a period of 1-3 years. In the event of case notification, collected data for each country has been compared to the overall population data available on WHO web site for that specific country.

Studies that reported prevalence rate directly [16, 17, 21] have their population size analyzed using the same means

and the information was then transformed to case notification rate which allowed more approximate sub-regional prevalence.

For studies where prevalence was categorized in the form of different tests available for CTS [as for nerve conduction test [12]] the information was standardized by calculating the average value.

4. Prevalence of Carpal Tunnel Syndrome (CTS)

Heterogeneity of the prevalence of CTS has been observed in all the included countries in this study of Western Europe (EUR A) which covered a wide confidence interval around an unweighted mean. So geographically divided weighted mean has been used to approach this issue. However, this is ideal to include data from all the countries thus reducing the need to estimate prevalence of countries with a larger population like Germany, Turkey and United Kingdom from the neighbouring countries.

Other than this, the reason of this heterogeneity in prevalence can also be due to difference in the size of population structure in different countries. Countries with more adult (16-65years) population would likely to have a higher rate of CTS than others. Mostly studies include the age group of over 16 years to up to 65 years as CTS is uncommon in younger than 16 age group. Though many of the articles showed distribution of CTS in both sexes, there has been a difference of CTS as distributed across sex as female are more prone to this disease. The relation between CTS and occupation has been another challenge, as CTS is believed to have a link with repetitive work. As a consequence it is likely that age, sex and occupational factors act as confounding variables for the presented estimate.

Based on this review the Western European region has a wide variance of the prevalence rate of Carpal Tunnel Syndrome between its member countries based on this review. The maximum reported was 43000/1000000 as reported in Germany in 2005 and minimum was 290/1000000 as reported in Portugal in 2006. The ratio of these two points was 148:1 with a range between the values of 42710/1000000. The corresponding median value was 3475/100000 with a 25th and 75th percentile for data being 1525/100000 and 9250/100000 respectively. The inter-quartile range was 37343.62. From the collective data set the estimated unweighted burden of CTS in Western Europe (EUR A) was 7326 cases per 100000 populations per year which equals to 36,886,410 cases based on the 503.5 million people living in this region in 2012. When the reported prevalence rate was weighted against the total population at risk reported in this study, the weighted mean of regional burden of CTS was 979/100000 person-years.

Table 3. Summary of data.

Statistics	Value
Mean prevalence	7326/100000
Median prevalence	3475/100000
Maximum reported prevalence	43000/100000
Minimum reported prevalence	290/100000
Max/Min ratio	148:1
Range	42710
25th percentile	1525/100000
75th percentile	9250/100000
Inter-quartile range	37343.62
Weighted mean prevalence	979/100000

Table 4. Prevalence of Carpal Tunnel Syndrome in Western European Countries.

Country	Total population	Population aged 15-65 (%)	Prevalence (%)
United Kingdom	62,989,551	66.2	0.39%
Germany	81,843,743	65.9	43.1%
Italy	60,820,696	65.6	1.1%
Spain	46,196,276	68.2	10.7%
France	6,532,772	64.8	3.15%
Denmark	5,580,516	65.4	3.1%
Hungary	9,957,731	68.5	10.88%
Portugal	10,541,840	66.8	0.29%
Sweden	9,482,855	65.2	3.8%
Turkey	74724269	67.2	2.8%
Netherlands	16730348	67.1	4.9%
Finland	5401267	66.3	3.8%

*Prevalence is expressed in person years, with 95% confidence interval

5. Discussion

This study did not find any article about total burden of CTS in general population of Western European region. Therefore, this paper includes the most recent studies conducted to determine regional burden of CTS in all the major counties of this region. Over all prevalence of Carpal tunnel Syndrome among adult population (15-65 years) in Western Europe varied from 0.29% to 43%. Despite wide ranges in prevalence estimates reported, this number suggests a strong prevalence of Carpal Tunnel Syndrome among adults in this region.

The majority of the population of Western European region is the inhabitants of the included countries. Therefore, though this study might not give the exact prevalence rate of CTS in this region, it will certainly help to get a better idea about the current most situation of this disease in this part of the world.

To eliminate bias this paper avoided comparing prevalence rate found in specific cities directly with the overall population of that specific country (as this would either give a lower or higher prevalence rate in that country). Therefore, this paper compared the prevalence rate reported in included articles with that of the population of a broad range of age groups as this will give a better result, closer to the real situation because individuals below 16 are commonly not affected by CTS.

It is worthwhile to mention some limitations of this study. Data from the selected articles are not comparable as these are collected from different settings (community vs. hospital), difference in patterns of data collection, difference in assessment tools used to determine Carpal Tunnel Syndrome etc. Therefore, the prevalence found in this study could not be used to assess trend of the disease over time.

Of the papers included in this study four [12, 15, 16] were based on regional burden of CTS in different countries at a city or provincial level. This is to be noted that regional studies are not always reflective of prevalence at national level. Same goes for studies based on specific hospital data [20]. Another weakness of this study was that several papers included in this study [17, 18, 21] were based on a group of

people who are engaged in a specific type of occupation, which increases the chance to be affected by CTS. Moreover, countries like Germany with much higher population than others, having the highest prevalence rate will have an impact on the results.

This study does not eliminate the potential chance of selection bias. Among these, the misclassification bias can be due to study designs [15] where the participants were selected based on symptoms and electrophysiological median neuropathy together, whilst patients who only had clinical symptoms but were electro-physiologically diagnosed negative were excluded. Thus this figure may be an underestimate because this excludes electro-physiologically normal subjects, which can affect the overall study result. Several included articles [11, 16, 20, 21] had a definite difference between the number of male and female participants where the participation of female were a lot higher comparing to male participants. Studies support the fact and it is also clinically supported that women have a higher risk of CTS. This higher rate of female participants may also affect the overall result of the study. The selection bias can also arise due to response bias as there has been a lack of response from the participants in several included studies like in Portugal (response rate 62.3%) [14], Netherlands (response rate 70%) [16] and Denmark (response rate 73%) [18].

For several included studies [14, 19] questionnaire were prepared and delivered to the participants from the interviewer, the chance of interviewer bias is also a possibility. Questionnaire also gives rise to the chance of recall bias, as participants were required to memorize incidence of exposure to work related or other types of risk factors. Furthermore, in the article from Turkey [20] researchers gathered old hospital data for the study where there may be missing data, which can also give rise to information bias.

The included articles also lacked a clear indication on how clinical criteria of CTS were applied. As a result main sources of observed variation in estimates of the prevalence rate of CTS can be due to different referral patterns rather than to real differences occurring among included countries.

Among the included papers there were several [11-14, 17, 19, 20, 22] which not only studied CTS but also other musculo-skeletal diseases. Therefore, this cannot be negated that sometimes there can be a false association where no association actually exists (type I error) or on the other hand may show no association where there is actually one (type II error). Both type I and type II errors may give rise to potential error due to chance. Also majority of the included articles did not talk about the statistical power of the corresponding studies so it cannot be detected that how much reliable the results are.

6. Conclusion

It has been confirmed through this study that Carpal Tunnel Syndrome remains as one of the most simple but frequently observed diseases among the adult population in

this region. Despite high prevalence of CTS in this region any standard criteria for clinical diagnosis of this disease have not yet been established. There is also no consensus on whether CTS is a clinical or electro-physiologically diagnosed disease. However, sufficient pathophysiological and epidemiological evidences are available for a causal relationship to be assumed between manual tasks and the occurrence of CTS. In particular it has been examined that working with hand held vibrating tools, performing repetitive work [17, 21] and even at times prolonged period of computer use [18] may also be considered as the risk factors for Carpal Tunnel Syndrome.

Policy measures that could be implemented may include raising awareness among people about the risk factors for this disease and providing a safe working environment. Raising individual awareness about work place safety should include health messages such as reducing force on grip while performing repetitive work, taking frequent breaks to relax grip, avoid bending wrists, improving posture and using CTS wrist brace.

Industries can take actions to educate their workers about these work place safety practices and thus increase awareness about the prevention of CTS. Furthermore, research to determine clear causal relationship of CTS with occupation and to reach a consensus about the disease's diagnostic criteria is needed.

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