**RISK FACTORS ON CARPAL TUNNEL SYNDROME AMONG FURNITURE MAKERS AT HOME INDUSTRIES IN DUREN SAWIT, 2020**

ALIA RAHMANNDANI\*, AZIZAH MUSLIHA FITRI, RIZKI AMALIA, ACIM HERI ISWANTO

*Program Studi S1 Kesehatan Masyarakat, Fakultas Ilmu Kesehatan*

*Universitas Pembangunan Nasional Veteran Jakarta*

*Kampus I Jl RS Fatmawati No. 1 Pondok Labu Jakarta Selatan 12450*

*Kampus II Jl Raya Limo Depok 16515, Indosesia*

*Email: [Upnvj@upn.ac.id](mailto:Upnvj@upn.ac.id)*

**ABSTRACT**

Furniture workers are at risk experiencing CTS because it involves using hands to operate hand-tools and machinery and do work manually for a long time without using Personal Protective Equipment (PPE) in the form of gloves that comply with standards. This study aimed to analyze the association between working duration, use of PPE, and intensity of machine vibration exposure with CTS at home furniture industry maker in Duren Sawit, 2020. This research method was a quantitative analytic with a cross-sectional design. The sampling technique used a total sampling of 57 workers consisting of machine user workers and finishing workers. Chi-Square bivariate tests showed a significant association between working duration (p= 0.002), use of PPE (p= 0.003), and intensity of machine vibration exposure (p= 0.009) with CTS. It is recommended for each home industry furniture to promote a safe workplace and safe work practices, educate the workers about CTS prevention, maintain the hand-tools and machinery to prevent injuries, provide rules regarding the use of PPE, and provide standardized anti-vibration gloves.

***Keywords*:** occupational diseases, hand-arm vibration, mechanical machine, manual work

1. **INTRODUCTION**

Carpal Tunnel Syndrome (CTS) is a collection of symptoms characterized by narrowing or inflammation due to pressure on the median nerve in the carpal tunnel which mostly occurs in the manufacturing industry [1]. Mild to moderate cases of CTS can cause symptoms of pain and paresthesia, which, if severe, can limit the function of the hands and wrists. CTS cases at a severe level can result in disability that hinders the patient's daily activities and causes losses to the company due to medical expenses and compensation [2].

Activities related to the emergence of CTS in workers, namely involving the use of hands in doing work that interacts directly with vibration exposure, are obtained from the use of machines and mechanical work equipment without the use of gloves that comply with standards resulting in complete vibrations on the worker's hands and unable to support the wrist position hand while doing manual work potentially increasing the pressure around the carpal tunnel [3]. The length of time the users work with their hands is not accompanied by optimal rest periods that have the potential to increase the exposure that causes CTS [4].

Risk factors that can contribute to CTS are age, gender, obesity, repetitive movements, awkward positions in the hands, as well as a number of medical conditions, namely trauma or fractures in the hands, rheumatoid arthritis, hypertension, and diabetes mellitus [5]. Employment factors such as length of work and years of service are also associated with the incidence of CTS [4].

The high risk of CTS on the job also involves high pressure and the use of a vibrating handheld machine [6]. In addition, CTS is also directly related to engine vibration intensity exposure in excess of the Threshold Value (NAV) [1].

Based on the National Health Interview Study (NHIS) report, the prevalence of CTS in the general population is estimated at 1.55% and is one of 3 types of diseases in the upper Cumulative Trauma Disorder (CTD) group with a prevalence of CTS of 40% [7]. In the European Union, CTS occupies the sixth position of all types of occupational diseases and since 2003 has been on the list of occupational diseases [8].

In 2003, the Office of Labor and Statistics in the United States stated that as many as 3.7 workers in the United States experienced absenteeism due to CTS [9]. Based on data from the World Health Organization (WHO) in 2010, cases of CTS are often found in industrialized countries with an estimated prevalence of 55--65% [10]. According to a report by the International Labor Organization (ILO), CTS is almost always found among workers. In China, in 2010 it was found that there was an increase in the number of CTS cases due to work by 30% compared to 2001 [11]. In Saudi Arabia, the prevalence of CTS in 2012 was 0.125% - 1%. Meanwhile, in 2017, the prevalence of CTS in the general population in European countries was 7.3% [12].

In Indonesia, the diagnosis of CTS among workers is still low, so the prevalence of CTS due to work cannot be clearly known, but based on the results of the Occupational Safety and Health (K3) survey by the Bangka Belitung Health Office, it was found that the prevalence of CTS cases in 2014 was 2.8% and an increase in 2015 to be 3.4% [10].

In Duren Sawit, Kelurahan Klender and Pondok Bambu to be precise, has become the center of a home industry for wood processing into furniture that has been around for decades. Along the road in this area, there are many home industries that process raw wood into frames, doors, cabinets, windows, tables, and others. Based on the results of the interview, there were 42 furniture home industry workers in Duren Sawit who complained about CTS including symptoms of pain and heat around the wrists which are often felt when waking up, tingling with frequent intensity both when using machines and after using machines, numbness in the hand area to experience gripping weakness. From the observations of all furniture home industry workers in Duren Sawit, it was found that most of the workers did not wear gloves that were in accordance with standards and found odd postures on the hands when operating the work machine or during the manual sanding process.

From the measurement results of the vibration intensity of the working machine, the acceleration value of the sanding machine, grinding machine, and shaved machine exceeds the TLV, as well as the machine usage time that lasts a long time in one working day. Therefore, this study aims to analyze the relationship between working duration, use of personal protective equipment (PPE), and intensity of machine vibration exposure with CTS experienced by workers in the furniture home industry in Duren Sawit, 2020.

1. **METHODS**

This research is a quantitative analytic study with a cross-sectional study approach. The dependent variable in this study is working duration, use of PPE, and intensity of machine vibration exposure, while the independent variable is Carpal Tunnel Syndrome (CTS). The population and sample of this study were 57 home furniture industry workers in Kelurahan Klender and Kelurahan Pondok Bambu consisting of 47 machine users and 10 finishing workers with the sampling technique using total sampling. The primary data of this study were obtained through filling out a questionnaire sheet, a phalen's test sheet, a RULA sheet, observing the use of PPE, and measuring the intensity of machine vibrations using a vibration meter. Secondary data were obtained from profile data and a general description of the work process in the home furniture industry. The data analysis method used the Chi-Square test to measure the strength of the relationship between the two variables.

1. **RESULTS**

From the measurement results of machine vibration intensity using the Lutron VB 8200 vibration meter, the value of the acceleration or acceleration of vibrations on the planer machine is 3.0 to 6.0, the sanding machine is 6.0 to 26.0, the grinding machine is more from 8.0, while on the shaved machine by more than 20.0. The result of the vibration acceleration value varies for each type of machine depending on the type, brand, and shape of the machine used by the worker.

**Table 1** Distribution of Respondents   
 Experience CTS

|  |  |  |
| --- | --- | --- |
| **CTS** | **n** | **%** |
| No Symptoms | 20 | 35 |
| With Symptoms | 37 | 65 |
| Total | 57 | 100 |

Source: Primary Data, 2020

Table 1 above, shows that of the 57 home furniture industry workers in Duren Sawit District, there were 20 respondents (35%) who did not experience CTS and there were 37 respondents (65%) who experienced CTS. Respondents were declared to have CTS if they felt ≥ 3 symptoms both at the time of doing the Phalen's test showed positive and negative results obtained through the results of the data normality test.

Table 2 Distribution of Respondents by   
 Types of CTS Symptoms Experienced   
 Respondents

|  |  |  |
| --- | --- | --- |
| **Types of CTS** | **n** | **%** |
| Pain in Various Occasions | 27 | 73 |
| Tingling in Various Occasions | 28 | 76 |
| Numb | 12 | 32 |
| Weakness in Hands | 19 | 51 |
| Pain at Night | 18 | 49 |
| Tingling at Night | 10 | 27 |
| Pain or Tingling in the Morning | 19 | 51 |
| Pain or Tingling at Work | 25 | 68 |

Source: Primary Data, 2020

Table 2 above, shows the types of CTS symptoms experienced by 37 furniture home industry workers in Duren Sawit District, it was found that the most common symptoms experienced by workers were constant tingling on various occasions as many as 28 respondents (76%) and pain. on various occasions as many as 27 respondents (73%). Meanwhile, the least symptom experienced was tingling at night as many as 10 respondents (27%).

**Table 3** Distribution Frequency of Analysis   
 Univariate

| **No.** | **Variable** | **n** | **%** |
| --- | --- | --- | --- |
| 1. | **Age** | | |
|  | < 38 Years | 23 | 40 |
|  | ≥ 38 Years | 34 | 60 |
| 2. | **Smoking Habit** | | |
|  | Mild | 16 | 28 |
|  | Moderate | 26 | 46 |
|  | Weight | 15 | 26 |
| 3. | **History of Hypertension** | | |
|  | Never | 39 | 68 |
|  | Ever | 18 | 32 |
|  | **Injury or Fracture to the Hand** | | |
|  | Never | 42 | 74 |
|  | Ever | 15 | 26 |
| 4. | **Working Period** | | |
|  | < 3 Years | 24 | 42 |
|  | ≥ 3 Years | 33 | 58 |
| 5. | **Working Duration** | | |
|  | ≤ 8 Hours | 18 | 32 |
|  | > 8 Hours | 39 | 68 |
| 6. | **Use of Personal Protective Equipment (PPE)** | | |
|  | Use | 16 | 28 |
|  | Do Not Use | 41 | 72 |
| 7. | **Hand Work Posture** | | |
|  | Small Risk | 11 | 19 |
|  | Moderate Risk | 35 | 62 |
|  | High Risk | 11 | 19 |
| 8. | **Intensity of Machine Vibration Exposure** | | |
|  | ≤ NAV (5m/s²) | 20 | 35 |
|  | >NAV (5m/s²) | 37 | 65 |

Source: Primary Data, 2020

Based on table 3 above, there are more workers in the furniture home industry in Duren Sawit District who are ≥ 38 years old as many as 34 respondents (60%). It is known that the smoking habits of workers are mostly included in the category of moderate smokers who smoke 10-20 cigarettes per day as many as 26 respondents (46%). It is known that most workers have never been diagnosed with hypertension in health services as many as 39 respondents (68%) and as many as 42 respondents (74%) have never been diagnosed with an injury or fracture in their hand.

From the work factor, it is known that there are more workers who have a working period of ≥ 3 years as many as 33 respondents (58%). Based on the working duration, there were more workers who worked for > 8 hours per day as many as 39 respondents (68%). It is known that the majority of workers do not wear PPE gloves as many as 41 respondents (72%). It is known that there are more than 35 respondents (62%) in the category of medium risk hand work posture. From the work environment factor, it is known that most workers have an intensity of exposure to machine vibrations that exceeds the TLV (5m / s²) as many as 37 respondents (65%).

**Table 4** Distribution Frequency of Analysis Bivariate

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Carpal Tunnel Syndrome* (CTS)** | | | | | | | | | | |
| **No.** | **Variable** | **No Symptoms** | | **With Symptoms** | | **Total** | | **P*value*** | **OR** | **95% CI** |
|  | | **n** | **%** | **n** | **%** | **n** | **%** |  | | |
| 1. | **age** | | | | | | | | | |
| < 38 Years | 7 | 30 | 16 | 70 | 23 | 100 | 0,747 | - | - |
| ≥ 38 Years | 13 | 38 | 21 | 62 | 34 | 100 |
| 2. | **Smoking Habit** | | | | | | | | | |
| Mild (< 10) | 8 | 50 | 8 | 50 | 18 | 100 | 0,310 | - | - |
| Moderate (10-20) | 7 | 27 | 19 | 73 | 24 | 100 |  |
| Weight (>20) | 5 | 33 | 10 | 67 | 15 | 100 |  |
| 3. | **History of Hypertension** | | | | | | | | | |
| Never | 12 | 31 | 27 | 69 | 39 | 100 | 0,480 | - | - |
| Ever | 8 | 44 | 10 | 56 | 18 | 100 |
| **Injury or Fracture to the Hand** | | | | | | | | | |
| Never | 15 | 36 | 27 | 64 | 42 | 100 | 1,000 | - | - |
| Ever | 5 | 33 | 10 | 67 | 15 | 100 |
| 4. | **Working Period** | | | | | | | | | |
| < 3Years | 7 | 29 | 17 | 71 | 24 | 100 | 0,605 | - | - |
| ≥ 3 Years | 13 | 39 | 20 | 61 | 33 | 100 |  |
| 5. | **Working Duration** | | | | | | | | | |
| ≤ 8 Hours | 12 | 67 | 6 | 33 | 18 | 100 | 0,002 | 1 | 2,219-27,071 |
| > 8 Hours | 8 | 20 | 31 | 80 | 39 | 100 | 7,750 |
| 6. | **Use of Personal Protective Equipment (PPE)** | | | | | | | | | |
| Use | 11 | 69 | 5 | 31 | 16 | 100 | 0,003 | 1 | 2,153-28,420 |
| Do Not Use | 9 | 22 | 32 | 78 | 41 | 100 | 7,822 |
| 7 | **Hand Work Posture** | | | | | | | | | |
| Small Risk | 6 | 55 | 5 | 45 | 11 | 100 | 0,325 | - | - |
| Moderate Risk | 11 | 31 | 24 | 69 | 35 | 100 |
| High Risk | 3 | 27 | 8 | 73 | 11 | 100 |
| 8. | **Intensity of Machine Vibration Exposure** | | | | | | | | | |
| ≤ NAV (5m/s²) | 12 | 60 | 8 | 40 | 20 | 100 | 0,009 | 1 | 1,656-17,850 |
| > NAV (5m/s²) | 8 | 22 | 29 | 78 | 37 | 100 | 5,438 |

Source: Primary Data, 2020

Based on table 4 above, the statistical test results show that there is no significant relationship between age and CTS, the value of p = 0.747 (p> 0.05) is obtained. The results of statistical tests proved that there was no significant relationship between smoking habits and CTS, the value of p = 0.310 (p> 0.05) was obtained.

Based on the results of statistical tests, it is known that there is no significant relationship between history of hypertension and CTS, the value of p = 0.480 (p> 0.05) is obtained and there is no significant relationship between history of injury or fracture of the hand with CTS, the value of p = 1,000 is obtained. (p> 0.05).

Based on the results of the statistical test, it states that there is no significant relationship between working period and CTS, it is known that the value of p = 0.605 (p> 0.05). From the results of the statistical test, it was stated that there was a significant relationship between working duration and CTS, it was known that the value of p = 0.002 (p <0.05). Based on the calculation of the risk estimate, the OR = 7,750 (95% CI; 2,219-27,071), meaning that respondents who work for more than 8 hours per day have a 7,750 times greater risk of experiencing CTS compared to respondents who have worked for less than 8 hours. /day. From the statistical test results, it was stated that there was a significant relationship between the use of PPE and CTS, it was known that the value of p = 0.003 (p <0.05). Based on the calculation of the risk estimate, the OR = 7.822 (95% CI; 2.153-28.420) was obtained, meaning that respondents who did not use PPE gloves had a risk of 7.822 times greater experiencing CTS compared to respondents who wore PPE gloves. The results of statistical tests stated that there was no significant relationship between hand work posture and CTS, it was known that the value of p = 0.325 (p> 0.05).

Based on the results of statistical tests, it proves that there is a significant relationship between the intensity of machine vibration exposure and CTS, the value of p = 0.009 (p <0.05) is obtained. Based on the risk estimate calculation, OR = 5,438 (95% CI; 1,656-17,850), meaning that respondents who have engine vibration exposure intensity exceeding TLV (5m / s²) are at 5,438 times greater risk of experiencing CTS compared to respondents who have less engine vibration exposure intensity from equal to TLV.

1. **DISCUSSIONS**

**Analysis of the Relationship Between Working Duration and CTS**

Based on the results of the bivariate analysis, it is known that CTS in home furniture industry workers is more experienced by respondents who work for more than 8 hours per day. The results of statistical tests showed that there was a significant relationship between length of work and the incidence of CTS (p <0.05). The results of this study are in line with the research of Sekarsari, et al. (2017) showing that there is a relationship between length of work and complaints of CTS among stone-breaking workers in North Moramo District with a value of p = 0.032 (p <0.05). From the research results, it is known that CTS complaints are mostly experienced by workers who work for ≥ 4 hours a day [13]. Extending the working time of excessive hand-wearing workers without high efficiency not only causes work fatigue, but also affects the health of workers [14]. Excessive working time can reduce worker rest times, resulting in increased repetitive movement of the hands and flexion and extension positions in the wrists [15].

In addition, the longer a person operates a vibrating device directly by hand, the greater the chance of getting CTS [16].The increase in working hours for furniture workers was due to the increase in orders for furniture, the limited number of workers in each industry, and the additional wages so that workers did not object to receiving additional working hours. However, if the order is under normal circumstances the working hours set by each industry range from 7 to 10 hours per day.

Based on the results of interviews, most of the machine using workers felt tingling symptoms and pain in the fingers and around the wrists, due to taking too long to hold objects in awkward positions along with high vibration exposure. The risk of CTS can arise when workers operate machines with high vibration for ≥ 4 hours [16]. The length of time the vibration exposure is received can disrupt blood flow to the tissues in the hands and fingers, causing discomfort and causing health problems in the hands [17].

The finishing workers also feel the same symptoms, because of the high frequency repetition of their hands. Manual work activities involving the hands for ≥ 4 hours cause the tissue around the carpal tunnel to experience stress easily which results in various symptoms in the distribution of the median nerve [13].

**Analysis of the Relationship Between Use of Personal Protective Equipment (PPE) and CTS**

Based on the results of the bivariate analysis, it is known that CTS in home furniture industry workers is more experienced by respondents who do not wear PPE gloves. The bivariate test results showed that there was a significant relationship between the use of PPE and the incidence of CTS (P <0.05). The results of this study are in line with the research conducted by Pangestuti and Widajati (2014) which states that there is a relationship between the use of PPE and complaints of CTS among grinding workers at PT DOK and Perkapalan Surabaya with a value of p = 0.00 (p <0.05). Most workers who experience CTS complaints do not use PPE gloves that comply with the standard.

It is important to use gloves that comply with standards, because the danger of vibration on the hand can injure the nerves in the wrist, reduce flexibility, and cause vascular contractions to the peripheral nerves that can cause numbness in the hand. In addition, the vibration hazard can cause local injury resulting in swelling and edema resulting in increased pressure in the carpal tunnel [18].

Based on the results of observations on all furniture home industry workers, there are only 16 workers who wear gloves when working. This type of conventional gloves is made of cloth and does not comply with the applicable standards. In addition, the cause of many machine users who do not wear gloves is because they complain about the discomfort when holding the machine together with wearing gloves. This discomfort causes the furniture production process to slow down.

The use of anti-vibration gloves is one of the easiest control measures to implement when the vibration hazard cannot be removed or adequately controlled [19]. Lack of awareness of the importance of wearing gloves according to standards causes the complete vibration exposure to spread to the hands of workers so that it cannot help maximally in preventing the onset of CTS [20]. Meanwhile, the importance of using gloves in finishing workers, because it can support and limit wrist movement, and prevent pressure to arise around the carpal tunnel [3]. Therefore, CTS for furniture workers is closely related to wearing PPE gloves, because most workers do not wear gloves according to the applicable standards.

**Analysis of the Relationship Between Intensity of Machine Vibration Exposure**

Based on the results of the bivariate analysis, it is known that CTS in home furniture industry workers is more experienced by respondents with an intensity of daily vibration exposure exceeding TLV (5m / s²). The results of statistical tests showed that there was a significant relationship between the intensity of engine vibration exposure and the incidence of CTS (P <0.05). The results of this study are in line with the research of Pangestuti and Widajati (2014) which states that there is a relationship between vibration intensity and CTS complaints on grinding workers at PT DOK and Perkapalan Surabaya with a value of p = 0.000 (p <0.05), because most of the complaints The CTS felt by respondents occurred during a few minutes using a grinding machine that had a vibration intensity exceeding TLV and the most felt complaint was pain.

Local vibrations generated by working tools such as grinding machines, shaved machines, and sandpaper machines can spread freely to the hands to the arms, if they occur every day it will cause discomfort in the workers' hands and will cause abnormalities in the structure of the bones, muscles, tendons, and nerves in the wrist, as well as increasing muscle contraction [18]. In addition, the amount of vibration energy entering the hand is also influenced by the strength of the hand grip when holding the machine handle and is an important factor in the assessment of vibration exposure [19].

In this study, the results of measurement of vibration intensity with a vibration meter for sanding machines, grinding machines, and shaved machines have a fairly high value of acceleration and vibration speed, in contrast to planer machines or spindle machines which have lower values ​​of acceleration and vibration speed. . From the calculation of the exposure to vibration intensity A (8) obtained by each worker, most of the results show that the value of A (8) exceeds the TLV (5m / s²).

The use of a vibrating machine with a vibration exposure intensity exceeding TLV which is carried out every day for a long enough time, especially when operating a machine that is not equipped with the use of anti-vibration gloves and without a damper attached to the handle of the machine causes the vibration to be fully transmitted to the hand without a reduction in the value of the intensity of vibration exposure, this causes workers to often complain of tingling and soreness while using or after using the machine. Workers have felt this complaint since the beginning using vibrating machines. Exposure to vibration with a vibration intensity exceeding TLV causes CTS to occur with a chance of 87.2% [16]. In addition, the greater the vibration exposure received by workers, it can aggravate and increase the symptoms felt by workers [21]. Therefore, the intensity of machine vibration exposure that exceeds the TLV greatly affects the emergence of CTS, especially for machine users in the furniture home industry, in Duren Sawit, because most workers are machine users.

1. **CONCLUSION**

In this study, the results showed that as many as 65% of respondents experienced CTS. The results of this study also indicate that there is a significant relationship between working duration, use of PPE, and intensity of machine vibration exposure with the CTS among furniture home industry workers in Duren Sawit. It is recommended to promote safe workplaces and safe work practices, educate workers about the prevention of CTS, provide regulations regarding the use of PPE, maintain hand tools and machines to prevent injuries, and provide anti-vibration gloves that are suitable for use. according to the standard in an effort to guarantee health protection on the hands of workers.

**ACKNOWLEDGEMENT**

This study is supported by thesis supervisor at the health sciences faculty of UPN Veteran Jakarta.

**REFERENCES**

[1] A. A. Pangestuti and N. Widajati, “Faktor Yang Berhubungan Dengan Keluhan Carpal Tunnel Syndrome Pada Pekerja Gerinda Di PT Dok Dan Perkapalan Surabaya,” *the Indonesian Journal of Occupational Safety and Health*, vol. 3, no. 1, 14–24 (2014).

[2] A. L. Hakim and R. Tjandra, “Hubungan Tingkat Keparahan Gejala Dan Status Fungsional Pada Pasien Carpal Tunnel Syndrome Diukur Menggunakan Carpal Tunnel Syndrome Assessment,” *Jurnal Kedokteran. Diponegoro*, vol. 5, no. 3, 174–187 (2016), doi: http://ejournal-s1.undip.ac.id/index.php/medico.

[3] F. S. Farhan, “Faktor-faktor yang Mempengaruhi Timbulnya Carpal Tunnel Syndrome pada Pengendara Ojek,” *Jurnal Manajemen. Kesehatan. Yayasan RS.Dr. Soetomo*, vol. 4, no. 2, 123 (2015), doi: 10.29241/jmk.v4i2.114.

[4] V. Selviyati, A. Camelia, and E. Sunarsih, “Analisis Determinan Kejadian Carpal Tunnel Syndrome (CTS) Pada Petani Penyadap Pohon Karet Di Desa Karang Manik Kecamatan Belitang Ii Kabupaten Oku Timur Determinantanalysis of Carpal Tunnel Syndrome (CTS) in the Farmers Tapper Rubber Trees At Karang Mani,” *Jurnal. Ilmu Kesehatan Masyarakat.*, vol. 7, no. 3, 198–208 (2016).

[5] A. Barcenilla, L. M. March, J. S. Chen, and P. N. Sambrook, “Carpal tunnel syndrome and its relationship to occupation: A meta-analysis,” *Rheumatology*, vol. 51, no. 2, 250–261 (2012), doi: 10.1093/rheumatology/ker108.

[6] R. Aroori, Somaiah dan Spence, “Carpal tunnel syndrome,” *Ulster Med J*, vol. 77, no. 1, 602–605 (2008), doi: 10.1016/B978-0-12-385157-4.00652-7.

[7] L. Tana, “Sindrom Terowongan Karpal pada Pekerja: Pencegahan dan Pengobatannya,” *Jurnal Kedokteran. Trisakti*, vol. 22, no. 3, 99–104 (2003).

[8] K. Nafasa, N. Nurimaba, and C. Tresnasari, “Hubungan Masa Kerja dengan Keluhan Carpal Tunnel Syndrome pada Karyawan Pengguna Komputer di Bank BJB Cabang Subang,” *Jurnal Integrasi Kesehatan dan Sains*, vol. 1, no. 1, 40–44 (2019).

[9] R. nur Fitriani, “Faktor-Faktor Yang Berhubungan Dengan Dugaan Carpal Tunnel Syndrome (CTS) Pada Operator Komputer Bagian Sekretarian Di Inspektorat Jenderal Kementerian Pekerjaan Umum Tahun 2012,” *Skripsi*, 39 (2012), doi: 10.5170/CERN-2007-003.241.

[10] M. Yunus, Neno Fitriani Hasbie, and G. R. Tami, “Hubungan Masa Kerja Dan Sikap Kerja Dengan Kejadian Carpal Tunnel Syndrom Pada Pekerja Pembuat Kerupuk Di Industri Pembuat Kerupuk Ahak Kecamatan Sungailiat Provinsi Bangka Belitung Tahun 2016,” *Jurnal Malahayati*, vol. 37, no. 1, 1–10 (2016), doi: http://ejurnalmalahayati.ac.id.

[11] International Labour Organization, “The Prevention Occupational Diseases,” *Encycl. Toxicol. Third Edition*, April, 1075–1076 (2013), doi: 10.1016/B978-0-12-386454-3.00617-5.

[12] M. G. D. PUTRA, “Hubungan Indeks Massa Tubuh Dengan Derajat Keparahan Carpal Tunnel Syndrome Di RSUP Dr. M. Djamil Padang Periode 2017-2018,” *Skripsi*, vol. 53, 9 (2019), doi: 10.1017/CBO9781107415324.004.

[13] D. Sekarsari, arum pratiwi, and A. Farzan, “Hubungan Lama Kerja, Gerakan Repetitif Dan Postur Janggal Pada Tangan Dengan Keluhan Carpal Tunnel Syndrome (CTS) Pada Pekerja Pemecah Batu Di Kecamatan Moramo Utara Kabupaten Konawe Selatan Tahun 2016,” *Jurnal. Ilmu Mahasiswa. Kesehatan Masyarakat Unsyiah*, vol. 2, no. 6, 1–9 (2017).

[14] R. Basuki, M. N. Jenie, and Z. Fikri, “Faktor Prediktor Carpal Tunnel Syndrome (CTS) pada Pengrajin Alat Tenun Bukan Mesin (ATBM)” *Jurnal Universitas Muhammadiyah Semarang*, vol. 1, no. 1, 1–6 (2016).

[15] E. Ken, R. Lisay, H. Polii, and V. Doda, “Hubungan Durasi Kerja Dengan Keluhan Carpal Tunnel Syndrome Pada Juru Ketik Di Kecamatan Malalayang Kota Manado,” *Jurnal Kedokteran Klinik*, vol. 1, no. 2, 046–052 (2017).

[16] A. W. Grace Pandiangan, I. Adiputra, and I. P. G. Adiatmika, “Hubungan Getaran Mekanis Mesin Gerinda Dengan Keluhan Carpal Tunnel Syndrome Pada Pekerja Bengkel Las Di Kota Denpasar,” *Maj. Ilm. Fisioter. Indones.*, vol. 5, no. 1, 3–6 (2016).

[17] H. Munawaroh, “Hubungan Getaran Mesin Dengan Keluhan Carpal Tunnel Syndrome (Subyektif) Pada Pekerja Bagian Produksi,” *Skripsi* (2012).

[18] Y. A. Pradana, “Hubungan Getaran Mekanis Terhadap Keluhan Carpal Tunnel Syndrome (CTS) Pada Pekerja Bagian Pemotongan Kayu Di Cv . Mulya Abadi,” *Skripsi* (2019).

[19] CCOHS, “Vibration - Measurement, Control and Standards,” *Government of Canada*, Available: https://www.ccohs.ca/oshanswers/phys\_agents/vibration/vibration\_measure.html#:~:text=Safe Work Practices,including gloves%2C to keep warm (2016).

[20] Y. Rusdi and H. Koesyanto, “Hubungan Antara Getaran Mesin Produksi Dengan Carpal Tunnel Syndrome,” *KESMAS - J. Kesehat. Masy.*, vol. 5, no. 2, 89–94 (2010), doi: 10.15294/kemas.v5i2.1865.

[21] F. Qoribullah, “Hubungan Getaran Lengan-Tangan Dengan Keluhan Carpal Tunnel Syndrome Pada Pekerja Home Industry Pandai Besi Di Kecamatan Sokobanah Sampang,” *Medical Technology and Public Health Journal*, vol. 4, no. 1, 38–45 (2020), doi: 10.33086/mtphj.v4i1.1165.