The Effect of Work Factors Moderated Individual Factors on Carpal Tunnel Syndrome (CTS) in Tea Harvesters at PTPN IV Sidamanik

Rahmi Wardani[1], Gerry Silaban[1], Taufik Ashar[1]
[1]Faculty of Public Health, Universitas Sumatera Utara

Email corespondence: rahmiwardani14@gmail.com

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Abstract

The industrial sector, especially tea plants, is a sector that has a positive impact on the development of the State. However, this development is also closely related to risk factors that can lead to occupational accidents and occupational diseases that require further treatment such as Carpal Tunnel Syndrome (CTS). This study was conducted to analyze work factors moderated individual factors on CTS in tea harvesters using machines at PTPN IV Sidamanik. This study used quantitative methods of cross sectional design with Thinel test and Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) on 98 workers using correlation test and Moderated Regression Analysis (MRA). The results showed a positive relationship between work and individual factors with CTS (p value <0.05). There was an increase in R square on the interaction of work factors with individual factors by 16.3% on the age variable, 2.4% on the smoking variable and 5.7% on the Body Mass Index (BMI) variable. Individual factors (age, smoking and BMI) strengthened the influence of work factors on CTS with significance <0.05. This study is expected to provide information, input and consideration to companies in making policies regarding occupational illness, especially CTS. And can increase workers' awareness to use personal protective equipment when working and conduct an examination if they find symptoms of CTS.

Keywords: Age, Body Mass Index, Carpal Tunnel Syndrome, Posture, Smoking

INTRODUCTION

The industrial sector, especially tea plants, is a sector that has a positive impact on the development of the country. Tea plants are one of Indonesia's profitable commodities. The decline in tea productivity in Indonesia is due to the unbalanced harvest process and must be balanced with good quality. This is related to farming factors, labour and picking techniques. To increase production, machines were created to maximise tea leaf harvesting (Kementan RI, 2020).

The total world tea production originating from Indonesia is 2%. Tea production in Indonesia in 2020 is ranked eighth in the world, with a production of 138,323 tons. Tea production in 2021 in Indonesia has been exported to 62 countries, with the majority of exports to Malaysia at as much as 13.12%, Russia at 12.63%, and Australia at 10.32%. One of the PTs that contribute a lot to tea exports is PT Perkebunan Nusantara, with 41% of the total domestic tea production dominated by black tea (Kemenko RI, 2022).

Indonesia also has the opportunity to increase export volumes with green tea. The government has also targeted that by 2024, Indonesia will control 2% to 2.5% of the tea market share. Tea production in Indonesia in 2021 is estimated at 129,529 tons, with the three largest

producers being West Java with 89,219 tons, Central Java with 14,616 tons and North Sumatra with 9,070 tons (Kementan RI, 2020).

According to the International Labor Organization (ILO), in 2018, as many as 2.78 million workers died every year in the world due to occupational accidents and occupational diseases, with 86.3% due to occupational diseases and 13.7% by occupational accidents. Occupational accidents and diseases occur annually in various countries (ILO, 2018).

Based on European Occupation Diseases Statistic (EODS) data, occupational diseases that attack the movement system are Musculoskeletal Disorders (MSDs) and Carpal Tunnel Syndrome (CTS). This occupational disease has increased 2002-2005 by 32%. 59% of occupational diseases covered by EODS are MSDs and Carpal Tunnel Syndrome (European Agency for Safety and Health at Work, 2010).

Data reports from the Occupational Safety and Health Administration (OSHA) show that around 900,000 workers experience Carpal Tunnel Syndrome annually. The total cost required for Carpal Tunnel Syndrome is also very large, more than 20 billion per year. After further examination, 6,245 workers or about 55.6% of workers, suffered from Carpal Tunnel Syndrome. Statistics on British Hospitals report the incidence of Carpal Tunnel Syndrome occurs in 28/10,000 people with a total of 8,346 sufferers (Burton et al., 2018)

The prevalence of Carpal Tunnel Syndrome in Indonesia still needs to be discovered exactly due to the lack of information and data available. In 2011, workers diagnosed with Carpal Tunnel Syndrome amounted to 5.6-15%. The results of the Basic Health Research (2013) explain that according to the Center for Research and Development disease eradication, Balitbang Health Jakarta examined that the incidence of Carpal Tunnel Syndrome experienced by high-risk garment workers amounted to 20.3% (Kemenkes RI, 2013).

According to Yassierli et al., (2020), disorders in the MSD system, in this case, Carpal Tunnel Syndrome, are caused by one or a combination of several risk factors. The more risk factors that occur, the higher the risk of the disorder. The main risk factor for Carpal Tunnel Syndrome is related to work factors experienced by workers, namely awkward and static postures, work with excessive muscle strength, pressure, repetitive motion, and vibration.

According to Qoribullah (2020), 33 blacksmith home industry workers in Sokobanah Sampang District, there were 11 (33.3%) workers experiencing moderate complaints, 21 (63.6%) experiencing severe complaints, and 1 (3.0%) workers experiencing very severe complaints with test results of sig value (2-tailed) of 0.01 which means there is a significant relationship between vibration and complaints of Carpal Tunnel Syndrome. Moreover, the correlation test results show a value of 0.778, meaning there is a strong relationship between

vibration and complaints of Carpal Tunnel Syndrome. So the importance of using personal protective equipment to minimize vibration.

This aligns with the research of Chairunnisa et al., (2021) the use of personal protective equipment is also closely related to Carpal Tunnel Syndrome, respondents who do not wear personal protective equipment have a 4.731 times greater chance of experiencing symptoms of Carpal Tunnel Syndrome than respondents who wear personal protective equipment. Personal protective equipment in the form of gloves can reduce vibrations which can injure the nerves in the wrist and cause contraction of blood vessels in the peripheral nerves, which can cause numbness in the hands.

In addition, supporting factors play a role in increasing the main risk of Carpal Tunnel Syndrome. These factors consist of age, gender, hobbies, injuries, health conditions, smoking, fatigue, body mass index, heredity and pregnancy. According to research by Hashimoto et al., (2020) factors that can affect Carpal Tunnel Syndrome are gender, body mass index and health conditions such as rheumatoid arthritis. This is in line with the research of Aulia et al. (2023), which states that there is a relationship between body mass index in patients with a history of diabetes militias on the incidence of Carpal Tunnel Syndrome. And according to Hartanti et al. (2018), complaints of Carpal Tunnel Syndrome are mostly experienced by workers with ages ≥ 30 years as many as 17 (42.5%) workers, and ages <30 as many as 11 (27.5%). Moreover, the chi-square test results showed a p-value of 0.027, which means there is a significant relationship between the age of workers and complaints of Carpal Tunnel Syndrome.

Based on a preliminary survey conducted on 30 male workers harvesting tea leaves using machines in Sidamanik Garden, it was found that workers experienced complaints in the hands (wrists to fingers) and arms (shoulders to wrists). Specific complaints experienced by workers such as complaints of pain or pain in the hands and arms of as many as 16 workers (53.33%), tingling in the fingers in as many as 13 workers (43.33%), numbness in as many as eight workers (26.66%) and swollen hands, especially in the morning as many as five workers (16.66%).

Machine tea harvesting has been going on for eight years, and the average working mass of workers is four years. Tea harvesting is carried out by three men with an average age of more than 40 years and smokers. The position of workers when harvesting tea with machines is on the right side of the machine held by one worker, on the left side of the machine held by one worker and one worker at the back of the machine to hold the harvest bags. Workers grasp the handle of the machine that holds the weight of the machine for 8 hours of

work in a standing position. Predominantly right-handed workers prefer positions supporting this, so work rotations are usually carried out by team agreements. Usually, the first rotation is carried out during working hours from 08.00 until 12.00, the time range is at 10.00, and the second rotation is carried out after the break at 13.30.

Workers harvest by grasping the machine's handle, which is designed using wood or long bamboo to connect the handle between the sides of the machine to facilitate the harvesting process. Workers must also control the machine so that the machine remains in a straight and parallel state so that no leaves are left behind, and the resulting harvest is also a young tea leaf and avoid grass. Workers also hold wood or bamboo in an awkward or unnatural position, which is one factor caused by the height of the tea tree during the harvesting process.

This condition triggers pressure on the muscles of the hands, especially the wrists and palms of workers, which, if done repeatedly, can cause persistent muscle pain and, if done continuously, can trigger Carpal Tunnel Syndrome in workers, especially workers who rarely do stretching before and after work. Based on this background description, researchers are interested in analyzing the factors that cause complaints of Carpal Tunnel Syndrome (CTS) in tea harvesters using machines at PTPN IV Sidamanik.

METHODS

This study uses quantitative methods with a cross-sectional design. This research was conducted at PTPN IV Sidamanik District Sidamanik Simalungun Regency. The choice of location is because the tea plantation is the most extensive land, so it requires the most workers to do the harvesting process. This is closely related to the incidence of Carpal Tunnel Syndrome (CTS) risk. This study began in August 2022 to January 2023.

The population in this study were all workers in the harvest section using machines at Sidamanik Farm, with as many as 102 harvesters. The sample in this study was harvest workers using machines in Sidamanik Gardens, totalling 102 people, using the total sampling method, which means that all populations were sampled in the study.

The inclusion criteria of the research sample are workers on tea harvesters using machines and scissors at PTPN IV Sidamanik who have worked for> 1 year and are willing to be research respondents. At the same time, the exclusion criteria for research samples are having a history of diseases such as rheumatoid arthritis and diabetes Mellitus and having trauma to the hands.

Data collection by examining complaints of Carpal Tunnel Syndrome (CTS) by physical examination using the Tinel's test method, filling out questionnaires conducted

directly by respondents, and filling out risk evaluation testing with the Job Strain Index **(**JSI) method. Research data analysis using the Pearson correlation test for normally distributed data and Spearman correlation non-parametric test if the data is not normal and using Moderated Regression Analysis (MRA) interaction test.

RESULTS

Table 1. Frequency Distribution of Occupational and Individual Factors on Carpal Tunnel Syndrome

Variable	N	%
Work factors		
Job Strain Index Value		
<3	25	25.5
3-7	56	57.1
>7	17	17.3
Total	98	100
Individual factors		
Age (years)		
≤ 25	3	3.1
26-35	27	27.6
36-45	44	44.9
46-55	24	24.5
Total	98	100
Smoking (cigarettes)		
No smoking	8	8.2
1-10	71	72.9
11-20	19	19.4
Total	98	100
Body Mass Index (BMI)		
<18.5	4	4.1
≥ 18.5 - < 24.9	81	82.7
≥25.0 - < 27.0	11	11.2
≥ 27.0	2	2.0
Total	98	100
Prevalence of Carpal Tunnel Syndrome (CTS)		
There is a left complaint	10	10.2
There is a right complaint	17	17.3
There are bilateral complaints	14	14.3
No complaints	57	58.2
Total	98	100
BCTQ Result		
11	-	-
12-22	38	38.8
23-33	58	59.2
34-44	2	2
45-55	-	-
Total	98	100

Based on Table 1. Workers with a Job Strain Index **(**JSI) value of <3 Alternatively, a safe category was 25 people (25.5%), workers with a Job Strain Index **(**JSI) value of 3-7 or a mild risk category were 56 people (57.1%), and there were no workers with a Job Strain Index **(**JSI) value> 7 or a high-risk category of 17 people (17.3%).

Workers with age ≤ 25 were three people (3.1%), aged 26-35 years were 27 people (27.6%), aged 36-45 years were 44 people (44.9%), and aged 46-55 years were 24 people (24.55%).

Based on the distribution of respondent categories based on the number of cigarettes workers smoke per day, workers who do not smoke are eight people (8.2%), workers with a light smoking category of 1-10 cigarettes are 71 people (72.4%), workers with a moderate smoking category of 11-20 cigarettes are 19 people (19.4%), and there are no heavy smokers, namely 21-30 cigarettes. Moreover, based on the distribution of Body Mass Index categories, workers in the underweight category (< 18.5) were four people (4.1%), workers in the normal category (≥ 18.5 - < 24.9) were 81 people (82.7%), workers in the overweight category (≥25.0 - < 27.0) were 11 people (11.2%). Workers in the obese category were two people (2%).

Workers were suspected of having Carpal Tunnel Syndrome as many as 41, with details of Carpal Tunnel Syndrome on the left hand alone for as many as ten people (24.4%), Carpal Tunnel Syndrome on the right hand alone for as many as 17 people (41.5%) and Carpal Tunnel Syndrome on the right and left hands (bilateral) as many as 14 people (34.1%).

Workers with Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) results in the category of mild complaints (12-22) amounted to 38 people (38.8%), workers with BCTQ results in the category of moderate complaints were 58 people (59.2%) and workers with BCTQ results in the severe category were two people (2%).

Table 2. The Relationship of Work Factors Moderated by Individual Factors to Carpal Tunnel Syndrome

Variable	R	P-value
Work factors		
Awkward and static postures	0,693	0,005
Individual factors		
Age	0,631	0,005
Smoking	0,378	0,005
Body mass index	0,502	0,005

Based on Table.2, the Pearson correlation test results are significant with the acquisition of p values for each variable. The awkward and static posture variable obtained a value of r = 0.693 with a significance of 0.0005. The conclusion is that the relationship between awkward and static postures with Carpal Tunnel Syndrome shows a strong and positive relationship, meaning that the more awkward and static postures increase, the higher the Carpal Tunnel Syndrome complaints. Statistical test results show a significant relationship between awkward and static postures with Carpal Tunnel Syndrome (p = 0.0005).

The age variable obtained a value of r = 0.631 with a significance of 0.0005. The conclusion is that the relationship between age and Carpal Tunnel Syndrome shows a strong and positive relationship, meaning that the increasing age, the higher the complaints of Carpal Tunnel Syndrome. The statistical test results showed a significant relationship between age and Carpal Tunnel Syndrome (p = 0.0005).

The smoking variable obtained a value of r = 0.378 with a significance of 0.0005. The conclusion is that the relationship between smoking and Carpal Tunnel Syndrome shows a moderate and positive relationship, meaning that the more smoking, the higher the complaints of Carpal Tunnel Syndrome. The statistical test results found a significant relationship between smoking and Carpal Tunnel Syndrome (p = 0.0005).

The Body Mass Index variable obtained a value of r = 0.502 with a significance of 0.0005. The conclusion is that the relationship between Body Mass Index and Carpal Tunnel Syndrome shows a strong and positive relationship, meaning that the increase in Body Mass Index, the higher the level of Carpal Tunnel Syndrome complaints. The statistical test results found a significant relationship between Body Mass Index and Carpal Tunnel Syndrome (p = 0.0005).

Table.3 Effect of Work Factors Moderated by Individual Factors on Carpal Tunnel Syndrome

Variable	*R square*
Occupational factors	
Awkward and static posture	0,480
Individual factors	
Age X awkward and static posture	0,643
Smoking X awkward and static posture	0,504
Body mass index X awkward and static posture	0,537

Based on Table 3. above, the R square number shows the coefficient of determination or the independent variable moderated in the influence on the dependent variable. The R square number in awkward and static postures is 0.480, meaning that the regression line equation we get can explain 48% of the variation in Carpal Tunnel Syndrome or the line equation obtained to explain the Carpal Tunnel Syndrome variable. In contrast, the rest is explained by other variables.

The R square number in awkward and static postures moderated by age is 0.643 or 64.3%, which can explain the Carpal Tunnel Syndrome variable. The interaction increased by 0.163 or 16.3%, which enlarged the regression line equation obtained to explain the Carpal Tunnel Syndrome variable.

The R square number in awkward and static postures moderated by smoking is 0.504 or 50.4%, which can explain the effect on Carpal Tunnel Syndrome. The interaction increased

by 0.024 or 2.4%, which enlarged the regression line equation obtained to explain the Carpal Tunnel Syndrome variable.

The R square number in awkward and static postures moderated by Body Mass Index is 0.537 or 53.7%, which can explain the effect on Carpal Tunnel Syndrome. An increase of 0.057 or 5.7% in the interaction enlarged the regression line equation obtained to explain the Carpal Tunnel Syndrome variable.

Table 4. Moderated Regression Analysis Test

Moderating Variable	F	B	P
Age x and static posture	56,396	-0,035	0,003
Smoking x awkward and static posture	31,816	0,057	0,040
BMI x awkward and static posture	36,377	-0,084	0,046

Based on the ANOVA or F test results on awkward and static posture variables moderated by age, the F value is 56.396 with a significance level <0.05. The results of the F test on awkward and static body posture variables moderated by smoking resulted in an F value of 31.816 with a significance level <0.05. In the F test results on awkward and static body posture variables moderated by BMI, the F value is 36.377 with a significance level of 0.000 <0.05.

In the interaction of awkward and static postures with age, the parameter coefficient value is -0.035 with a significance level of 0.003> 0.05. In the interaction of awkward and static postures with smoking, the parameter coefficient value is 0.057, with a significance level of 0.040 < 0.05. In the interaction of awkward and static postures with BMI, the parameter coefficient value is -0.084, with a significance level of 0.044 <0.05.

DISCUSSION

The Effect of Work Factors Moderated by Individual Factors on Carpal Tunnel Syndrome

Based on the results of the analysis that has been carried out on awkward and static postures, it explains the variation of Carpal Tunnel Syndrome with significant results. After interaction with individual factors, there was a significant increase in the three variables with awkward and static postures, namely age, smoking, and body mass index.

After analysis through, the F test explains that work factors moderated by individual factors together affect the occurrence of Carpal Tunnel Syndrome. Moreover, based on the individual parameter significance test explains that individual factors, both age, smoking and Body Mass Index, are all three significant moderating variables in this study. This means that these variables strengthen the influence of work factors on Carpal Tunnel Syndrome.

This is in line with Stack et al., (2016), which explain that the risk factors for Carpal Tunnel Syndrome consist of work and contributing factors or moderate factors. Moreover, individual factors are moderate in this research related to age, smoking and Body mass index.

According to Erick et al., (2021), there is a significant relationship between work factors and Carpal Tunnel Syndrome with significance ($p < 0.001$). Factors in work in this study were associated with awkward postures and excessive use of hand muscles, use of tools and workload with the amount of Carpal Tunnel Syndrome (OR 2.88, 95% CI) compared to those who did not work. Carpal Tunnel Syndrome occurs cumulatively due to repeated exposure over time.

Work factors are closely related to static anthropometric measures as the basis for designing and operating machinery or work equipment. The rules in the standing position are shoulder height, elbow height and hip height, front length and arm length. Ergonomics has been set for a good height for tools when manual handwork is preferably 5-10 cm below elbow height. Moreover, if in a standing position and the work is done on a table, the elbow height plateau is a plateau of 0, so the rules that apply are for work that requires accuracy of 0 + (5-10) cm, for light work 0-(5+10) cm and heavy work that needs to lift heavy items and requires working with back muscles 0-(10-20) cm. However, this position rule is very difficult to do in tea harvesting work with machines considering the height of workers and the height of tea trees vary. The company has made rules for low and medium-plant harvesting using machines to reduce the difficulty of reaching during harvest. While for plants that have started to grow tall, the harvesting process uses scissors. However, the height of the tea plants is only sometimes to the applicable ergonomic rules.

Another rule for workers with or workload that must walk on an uphill road, the optimum degree of incline is 100. Given that the location of this study is a highland and hilly area, it will be difficult to apply this rule to workers. For slightly uphill work locations, workers will expend muscle strength in the arms and legs to maintain their stability and tools so that it will not interfere with the harvest.

Based on data analysis explained through the Job Strain Index **(**JSI) value, it is known that workers need to be more ergonomic in doing their work. Workers in the unsafe category are more than workers in the safe category. This is because the attitude of the hands and wrists is not in a good position in extension, flexion or ulnar deviation. The Job Strain Index **(**JSI) table explains that a good wrist extension is $< 25^{o}$, flexion $< 15^{o}$ and ulnar deviation $< 15^{o}$.

The static position carried out by workers on the hands causes very little movement. If carried out for a long period, this position causes the muscles to contract continuously and can

cause stress or pressure on the hands. The direct pressure on the hand that grips the tool causes the soft hand muscle tissue to receive direct pressure from the tool handle, which can cause persistent pain (Hutabarat, 2017).

Based on the harvesting process carried out by workers, it is very difficult to avoid awkward and static posture factors, considering that workers must adjust the height of the machine and the height of the tea plant to the slope of the land to maximize yield. So there is a need to adjust work tools to minimize the occurrence of Carpal Tunnel Syndrome. Indonesia is still dependent on the technological development of developed countries in the procurement of industrial equipment, so many imported production machines are based on the anthropometry of their workers, so they are not suitable for use in Indonesia. If done for a long time, this causes complaints and muscle injuries (Hutabarat, 2017). Such as machine handles that are added with wooden or bamboo tools to support the machine and make it easier to carry the machine during harvesting. So it is necessary to design by the anthropometry of workers.

Based on the study results, 57 workers (58.16%) aged≥ 40 dominated, getting BCTQ values in the moderate and severe categories. This is likely because the higher the age of the worker, the more the physical ability of the worker's energy decreases, which is caused by hormones, so they are more susceptible to Carpal Tunnel Syndrome.

As we age, the repair process in our body takes longer. The incidence of Carpal Tunnel Syndrome also increases linearly with age and triggers gradual damage and loss of function of the median nerve fibres.

The age of workers in this study is also in line with the working period. In this study, there were 46 workers with a working period of 8-19 years (46.9%). Almost half of the workers do this work for a long time. This greatly affects the condition of carpal tunnel on the wrist of workers. However, workers are less aware of this and consider that the complaints experienced are common to everyone when someone works. Smoking is associated with reduced blood supply, oxidative stress, and systemic inflammation, which can damage peripheral nerves and make them more susceptible to compression neuropathy; smoking can also increase the risk of median nerve damage through toxic effects.

Researchers are still considering the relationship between smoking and Carpal Tunnel Syndrome. Lampainen et al., (2022) explained that of the many journals that fit the inclusion criteria, no association between smoking and Carpal Tunnel Syndrome was found in case-control or cohort studies. However, on the contrary, for meta-analysis of cross-sectional studies, many found an association between smoking and Carpal Tunnel Syndrome. Body Mass Index in the obese group is closely related to the incidence of Carpal Tunnel Syndrome. Being

overweight will cause swelling inside the carpal tunnel, or increased fat deposition can reduce carpal tunnel space due to increased hydrostatic pressure in the carpal tunnel. Pressure can occur through fat tissue accumulation, which will have a compression effect on the median nerve in the carpal tunnel (Ulbrichtová et al., 2020).

CONCLUSIONS

The conclusion obtained from the results of the analysis is that there is an influence of work factors (awkward and static posture) moderated by individual factors (age, smoking, BMI) on complaints of Carpal Tunnel Syndrome (CTS).

For PTPN IV companies, a special examination is needed to detect Carpal Tunnel Syndrome in prospective new workers, and periodic examinations are carried out, including anamnesis and prophylaxis, as early detection of occupational diseases covering a large scale, namely musculoskeletal disorders, including Carpal Tunnel Syndrome. Workers are given counselling on the early symptoms of Carpal Tunnel Syndrome and informed to examine at the Company Hospital if these symptoms occur immediately. The company also makes SOPs and socializes these SOPs to workers. Moreover, there is a notice from the foreman to do stretching or stretching between work hours in addition to rest hours.

Workers can warm up before work. Perform simple isometric exercises for 3 to 5 minutes every hour to strengthen the wrist, hand, and shoulder muscles to improve blood flow and reduce the potential for Carpal Tunnel Syndrome. Workers must immediately seek medical attention at the Company Hospital if they experience any early symptoms of Carpal Tunnel Syndrome. Moreover, workers must use gloves as personal protective equipment as a direct buffer from machine handles.

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