Antorcha
The Official Research Journal of Undergraduate Students
Colegio de San Juan de Letran – Manila
Volume 11 Issue 1
EISSN: 2244-632X

AN ERGONOMIC ANALYSIS ABOUT RISK FACTORS OF CARPAL TUNNEL SYNDROME FOR ANGKAS DRIVERS IN METRO MANILA

Ricky Allen A. Bernabe[1], Genevieve M. Lugo[1], Katrina L. Lee[2]
[1]Industrial Engineering Student, College of Engineering and Information Technology
[2]Faculty Member, College of Engineering and Information Technology

ABSTRACT

This study examines the ergonomic and demographic factors that contribute to Carpal Tunnel Syndrome (CTS) in Angkas motorcycle taxi drivers in Metro Manila. The Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ) and structured surveys are used in this quantitative study to assess risk factors and symptoms. The findings show a significant correlation between an increased risk of CTS and higher BMI, longer work hours, and more years of driving experience. The prevalence of symptoms like hand pain, numbness, and difficulty gripping was significantly higher among drivers who worked more than 10 hours a day or who had a BMI over 25. The strong relationship between CTS development and prolonged repetitive tasks was further highlighted by regression analysis. Measures like required rest periods, ergonomic handle modifications, and BMI management programs are essential for lowering the risk of CTS in motorbike taxi drivers. To improve the occupational health and safety of drivers in the motorcycle taxi industry, this study emphasizes the significance of addressing ergonomic risk factors through customized workplace interventions, better work schedules, and routine health assessments.

Keywords: *Musculoskeletal disorders, repetitive tasks, ergonomic interventions, angkas drivers, carpal tunnel syndrome.*

INTRODUCTION

Motorcycle taxis (MC Taxi), which are a kind of transportation where riders are carried on motorcycles. Motorbike taxis in the Philippines are a common and effective means of navigating through traffic in numerous urban areas, particularly during rush hour if cars can be stuck in traffic jams. According to Machado Sanchez et al. (2019), drivers of urban transportation, particularly those operating taxis and motorcycle taxis, are subject to unique occupational-related environmental, social, and health conditions. MC taxi drivers are workers who are more likely to face health risks, which can negatively affect their quality of life, particularly in the physical world. MC taxi drivers scored lower on the evaluation, wherein this fact may be connected to the negative impact of the occupation on the seven aspects: mobility, activities of daily living, energy and fatigue, sleep and rest, pain and discomfort, dependency on medicine or treatments, and ability to work.

In addition to Machado Sanchez et al. (2019), there is also pain in the upper and lower limbs of a MC Taxi driver, wherein they frequently lack the physical conditioning of the particular muscles required in a riding posture, which results in lumbar and cervical/head pain as well as weariness and discomfort. Musculoskeletal disorders (MSDs) include carpal tunnel syndrome (CTS), wherein the muscles, nerves, ligaments, tendons, joints, cartilage, and spinal discs are all impacted by MSDs. According to Titis Mariyamah et al. (2024), there is an increasing volume of MC Taxis that makes motorbike taxi drivers more active, which increases the risk of CTS because of the awkward wrist posture that results from riding a motorcycle (the wrist is too long on the handlebars with repetitive motion), which affects the blood supply and nerves in the wrist and hand

While Angkas has addressed the transportation needs of busy people in Metro Manila, the occupational hazards associated with motorcycle riding, especially for prolonged periods, cannot be overlooked. Motorcycle riders are exposed to various ergonomic challenges that can predispose them to musculoskeletal disorders (MSDs) over time. Carpal Tunnel Syndrome (CTS) stands out as one of the most prevalent and weakening conditions, particularly among individuals engaged in activities requiring repetitive hand movements and prolonged wrist flexion. Mayo Clinic (2024) explained that CTS is characterized by compression of the median nerve as it passes through the carpal tunnel in the wrist, which leads to symptoms such as pain, numbness, tingling, and weakness in the hand and fingers. Activities that involve repetitive wrist motions, such as gripping handlebars and manipulating throttle controls, can exacerbate the condition and increase the risk of developing CTS. Despite the growing recognition of the ergonomic challenges faced by motorcycle riders, including Angkas drivers, there remains a lack of comprehensive studies examining the risk factors of CTS within this population. Existing research studies often focuses on broader occupational groups or fails to address the specific ergonomic demands of motorcycle ride-hailing services.

This study seeks to fill this gap by conducting an ergonomic analysis of musculoskeletal disorders, with a particular focus on CTS among Angkas drivers in Metro Manila. By identifying the ergonomic risk factors contributing to CTS among this population and assessing the severity of CTS symptoms, this study aims to inform targeted interventions and preventive measures to safeguard the health and well-being of Angkas drivers and enhance their occupational safety. Through a comprehensive understanding of the ergonomic factors influencing CTS among Angkas drivers, this study endeavors to contribute valuable insights to the field of occupational health and ergonomics, with implications for the broader community of motorcycle riders and ride-hailing service providers in Metro Manila.

Theoretical Background

Theoretical Framework

One of the theories that address Carpal Tunnel Syndrome (CTS) in the workplace is the Biomechanical Stress Theory, authored by Marras, W. & Karwowski, W. (2006). This theory emphasizes that musculoskeletal disorders (MSDs) in a workplace may result from

excessive biomechanical stress on the musculoskeletal system, such as repeated or sustained exposure to awkward postures, high force exertions, and repetitive motions. This theory is particularly relevant to motorcycle taxi drivers, whose job often involves awkward postures and repetitive movements, such as gripping handlebars and operating the throttle. The Biomechanical Stress Theory provides a framework for understanding how ergonomic interventions can reduce these biomechanical stressors and prevent MSDs, making it applicable for assessing and improving the working conditions of motorcycle taxi drivers to mitigate the risk of CTS.

A more in-depth understanding of CTS is provided by the Pathophysiology of Carpal Tunnel Syndrome, as described by Aboong, M. (2015). This theory explains that CTS occurs when the median nerve, which runs from the forearm into the palm, becomes compressed at the wrist. The carpal tunnel is a narrow, rigid passageway of ligament and bones at the base of the hand that houses the median nerve and tendons. Continuous pressure on the median nerve can lead to symptoms such as numbness, tingling, pain, and weakness in the hand. This pathophysiological perspective is crucial for identifying how the prolonged and repetitive use of motorcycle controls can exacerbate CTS among drivers, emphasizing the need for ergonomic solutions to alleviate this pressure.

Furthermore, the Neutral Posture Theory, authored by Grandjean, E. (1988), emphasizes the importance of maintaining natural body alignments and minimizing deviations from neutral postures to reduce biomechanical stress on the musculoskeletal system. This theory highlights that designing tasks and work environments to promote neutral postures can help prevent MSDs by reducing muscle fatigue and strain. For motorcycle taxi drivers, implementing ergonomic interventions that promote neutral postures while riding, such as adjustable handlebar positions and improved seating design, can help reduce the risk of developing CTS.

Literature Review

Motorcycle taxis, a crucial element of the transportation network in Metro Manila, have evolved significantly with the advent of ride-hailing platforms such as Angkas. These services provide a structured, professional approach to transportation, connecting commuters with trained motorcycle drivers and offering a flexible solution to the city's traffic congestion. Despite their benefits, the nature of the job poses substantial health risks to the drivers, who typically work long hours under challenging conditions. Studies highlight a high prevalence of musculoskeletal disorders (MSDs) among motorcycle taxi drivers, stemming from repetitive tasks and poor ergonomic conditions. For instance, research by the International Information and Engineering Technology Association (2022) found that a significant percentage of drivers experience pain in various parts of their bodies, including the neck, shoulders, and buttocks, due to prolonged hours of riding and exposure to physical strain.

Physical ergonomics plays a pivotal role in addressing these occupational health issues. As a field dedicated to optimizing human interactions with their environment, physical ergonomics seeks to minimize physical strain and enhance comfort, safety, and productivity. By aligning workplace design and tools with human capabilities and limitations, ergonomists aim to prevent injuries and improve overall well-being. The principles of physical ergonomics are crucial for motorcycle taxi drivers, whose jobs require sustained awkward postures and repetitive movements that can lead to severe health issues, such as Carpal Tunnel Syndrome (CTS). This branch of ergonomics emphasizes the need for ergonomic interventions in reducing the risk of MSDs, underscoring the importance of creating environments that support optimal human performance.

Carpal Tunnel Syndrome (CTS), one of the most common musculoskeletal disorders affecting motorcycle taxi drivers, is characterized by the compression of the median nerve within the carpal tunnel of the wrist. Symptoms include numbness, tingling, pain, and weakness in the hand, which can significantly impair a driver's ability to work and their overall quality of life. The repetitive nature of tasks such as gripping handlebars and operating the throttle, combined with prolonged wrist flexion and exposure to vibration, contribute to the development of CTS among these drivers. Studies, such as those by the Mayo Clinic (2024) and Khokar & Mohsin Ali (2023), demonstrate the high prevalence of CTS and other MSDs among motorcycle taxi drivers, highlighting the critical need for ergonomic solutions to mitigate these risks.

Ergonomic assessment tools like the Rapid Upper Limb Assessment (RULA) are essential in evaluating and addressing the risk of CTS. RULA focuses on assessing the postures, forces, and movements of the upper limbs, making it particularly relevant for identifying CTS risks among motorcycle taxi drivers. It evaluates wrist positions and repetitive tasks, guiding the development of targeted ergonomic interventions. This tool enables a thorough analysis of the ergonomic factors affecting motorcycle taxi drivers, supporting the implementation of effective interventions to reduce CTS risks and enhance their occupational safety and health.

Literature Gap

Many studies on musculoskeletal disorders (MSDs) among motorcycle taxi drivers primarily focus on their general prevalence, without thoroughly examining specific contributing factors. These include the duration and frequency of repetitive tasks, the particular postures maintained during rides, and the impact of external elements such as road conditions and motorcycle design. In the Philippines, research specifically addressing Carpal Tunnel Syndrome (CTS) among motorcycle taxi drivers is notably limited. This is significant given that the repetitive hand and wrist movements required for operating a motorcycle may increase the risk of developing CTS. The limited research on this topic can be attributed to the relatively recent establishment of the motorcycle taxi industry in the country. However, with the rapid growth and continued expansion of this industry, the need for such studies is becoming increasingly urgent. Understanding and addressing these occupational health concerns is essential to support the safety and well-being of motorcycle taxi drivers, who are vital to this growing sector.

Based on the identified research gap, the study established the following null hypotheses. It was hypothesized that ergonomic risk factors (H01), working hours (H02), and the age of the drivers (H03) each have no direct effect on the development of Carpal Tunnel Syndrome (CTS) among Angkas drivers in Metro Manila.

Conceptual Framework

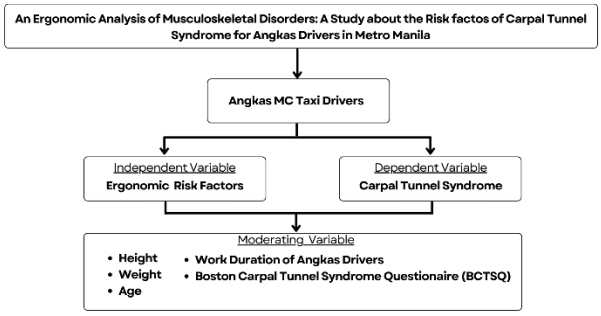

Figure 1. Conceptual Framework

Figure 1. shows the conceptual framework outlines the key elements of the study, focusing on identifying ergonomic risk factors and their impact on Carpal Tunnel Syndrome (CTS) among motorcycle taxi drivers specifically the Angkas drivers in Metro Manila. The independent variable holds various factors within the work environment, such as work environment, awkward posture, and vibrations, while the dependent variables represent the occurrence and severity of CTS. Moderator variables, including Height, Weight, Age, work duration, influence the relationship between ergonomic risk factors and CTS, reflecting the relationship between individual characteristics and workplace conditions.

Furthermore, theoretical frameworks, such as the Biochemical Stress Theory and Neutral Posture Theory, provide theoretical lenses through which to understand the mechanisms causing the development of CTS. By gathering demographic data and employing the Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ), the study aims to explain the potential risk of ergonomic factors that results to the development of CTS among Angkas drivers and identify prevalent ergonomic risk factors.

METHODOLOGY

Research Design

The researchers decided to use a diagnostic research design that mainly focuses on knowing the root cause of problems. The problem was highlighted in the supporting data of this study. It was highlighted that the problem faced by Angkas is the development of Musculoskeletal Disorders (MSDs) particularly carpal tunnel syndrome (CTS). With that, the researchers wanted to investigate if the ergonomic risk factors such as the workload, duration of work, age, working experience, and working environment of motorcycle taxi drivers have a direct effect on the development of carpal tunnel syndrome.

Subject and Study Site

The subject of this study is motorcycle taxi drivers. According to the website, mrandmrshowe (2021) Angkas has an age qualification from 21 – 55 years old. In addition, this study focused on ages 22 years old with at least one-year experience in motorcycling to 55 years old working in Angkas. This subject was used to obtain data such as their workload duration of work, age, working experience, and working environment. The subject answers were used as quantitative data to assess if the ergonomic risk factors mentioned above have a direct effect on the development of Carpal Tunnel Syndrome (CTS).

Furthermore, the Angkas has a total population of 40,000 riders, it was given directly by an Angkas employee, and the study site will be in Metro Manila. The researchers surveyed the said location and were answered by the Angkas drivers. The researchers decided to survey the said location since the current main operations of Angkas are in Metro Manila.

Research Instruments

The researchers used survey questionnaires as research instruments. The researchers aim to gather data from the selected respondents which are Angkas drivers working in Metro Manila. The study utilized a structured questionnaire as the main instrument for data collection. The questionnaire was administered to the respondents, with a focused on assessing the ergonomic risk factors that Angkas drivers face in doing their work.

Survey questionnaires were structured with a basis from the Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ). This instrument was used to analyze the carpal tunnel syndrome (CTS) symptoms in an ergonomic or occupational health context of the Angkas driver. In order to determine the appropriate sample size, the researchers utilized Slovin's formula. Slovin's formula is employed to calculate the sample size needed to achieve a desired confidence level, particularly when there is limited knowledge about the behavior or distribution of a population.

Data Gathering Procedure

Identification of the respondents and the location of where the data gathering was conducted. The researchers treated Angkas drivers as the respondents of the study and the location of data gathering is limited to Metro Manila. The researchers focused on identifying the ergonomic risk factors that contribute to the development of Angkas drivers. Ergonomic risk factors may include workplace environment such as work duration. The researchers released a survey that focused on identifying the ergonomic risk factors and demographics of the respondents. The researchers also decided to consider using the Boston Carpal Tunnel Syndrome Questionnaire (BCTSQ) and Rula Assessment to help to identify the risk factors of repetitive tasks.

The survey was released and distributed to the Facebook group of Angkas which is publicly visible to people. The survey was treated as the data for this study. The collection of the data will then be recorded, however, due to the privacy implications; the researchers only presented the results of the survey. With the collected data, the researchers analyzed the data and interpreted the results based on the theories, objectives, and statements of the problem used in this study.

Ethical Considerations

In this study, ethical consideration is critical. It hinders data fabrication or falsification, hence promoting the core purpose of research: the pursuit of knowledge and truth. Several aspects will be considered to ensure the quality and integrity of this research. The Research and Publication Department of Colegio de San Juan de Letran Manila thoroughly checked the survey instrument during the validation process including the ethical consideration. The confidentiality of the information provided by respondents, specifically the motorcycle taxi drivers observed by the researchers. With that being said, the information of the respondents was not revealed. The protocol was explained to the respondents, including the nature of the study, its purpose, and as well as the expected output. Respondents were asked to participate in this study voluntarily. Furthermore, before answering the survey, the Angkas driver's consent were considered. The survey questionnaires were safely kept in a password-protected zip file to ensure the confidentiality and precision of the data collected. This precaution was put in place to protect participant responses from unwanted access or disclosure and to guarantee the security and privacy of all data gathered during our research study.

Data Analysis

The researchers used linear statistics, in order to predict the course of future events, an algorithm known as linear regression establishes a relationship that is linear among an independent variable and a dependent variable Kanade (2023). Based on this, linear regression is a controlled learning algorithm that predicts continuous or numerical factors by simulating the mathematical connection between variables. When the data contains at least two variables, this analysis method is beneficial.

Since linear models can take into account a variety of variables (such as continuous, interval, nominal, and ordinal), and take into consideration organized observations in the independent variables (such as hierarchical or repeatedly measured models) and dependent

variables multi- level models). Probability and multiple link functions can be utilized with linear models' distributions, Torres and Akbaritabar (2024).

RESULTS AND DISCUSSION

Table 1. Linear regression on Ergonomic Risk Factors and CTS

Independent Variable	Dependent Variable	Standardized Coefficients Beta	Computed - t	p-value	Decision	Conclusion
Ergonomic Risk Factors	Carpal Tunnel Syndrome	.401	8.736	<.001	Reject Ho	Significant

Table 1 shows the simple linear regression model with Carpal Tunnel Syndrome as the dependent variable and the combined ergonomic risk factors such as age, height, weight, years of work experience as Angkas driver and work hours per day as the predictor. The standardized coefficient beta of 0.401 with t-value of 8.736 and the p-value is 0.001, means the combined ergonomic risk factors are a highly significant predictor of Carpal Tunnel Syndrome. The positive coefficient indicates that as the ergonomic risk factor increases, the possibility of having carpal tunnel syndrome also increases. Since p-value is less than .05 significance level, then we reject Ho. We can therefore conclude that Ergonomic risk factors such as age, height, weight, years of work experience as an Angkas driver and work hours per day are a significant predictor of carpal tunnel syndrome, with a substantial positive association among Angkas drivers in Metro Manila.

Table 2. Multiple regression ERF to CTS

Independent Variable	Dependent Variable	Standardized Coefficients Beta	Computed - t	p-value	Decision	Conclusion
Age	Carpal Tunnel Syndrome	.029	.624	.533	Do not Reject Ho	Not Significant
Height		.103	2.309	0.42	Reject Ho	Significant
Weight		.171	3.279	.001	Reject Ho	Significant
Work Experience		.249	4.665	<.001	Reject Ho	Significant
Daily work hours		.147	2.766	.006	Reject Ho	Significant

Table 2 shows the results of a multiple linear regression analysis with the CTS as the dependent variable and the different ergonomic risk factors as independent variables. The standardized coefficient beta for Age is 0.029 with a computed t-value of .624. The p-value is 0.533, indicating that Age does not significantly affect the development of CTS. Height has a coefficient of 0.103 and a p-value of 0.042, which is below the 0.05 level of significance. This suggests that height is a statistically significant predictor of the development of CTS, with a positive effect. Weight has a coefficient of .171 and is statistically significant (p=0.001), indicating that as weight increases, the development of CTS also increases. The coefficient for Work experience as an Angkas driver is .249, with a very low p-value (<0.001), indicating a strong, positive, and statistically significant effect on the development of CTS. Work hours per day have a coefficient of .147 and are also statistically significant (p=0.006), suggesting that more work hours per day are associated with the development of CTS. In summary, we can therefore conclude that height, weight, work experience, and daily work hours are significant predictors of the development of CTS. On the other hand, age is not a significant predictor of the development of CTS. The standardized coefficients (Beta) of the five(5) ergonomic risk factors show the relative impact of each variable on the development of CTS, with Work experience having the strongest effect (β=0.249), followed by Weight (β=0.171) and Work hours (β=0.147)

Table 3. Linear regression on result of daily work hours and CTS

Independent Variable	Dependent Variable	Beta	Std. Error	p-value	Decision	Conclusion
Daily work hours	Carpal Tunnel Syndrome	5.877	.860	<.001	Reject Ho	Significant

Note: Unstandardized coefficient

Table 3 provides the results of a linear regression analysis with the development of CTS as the dependent variable and daily Work hours as the predictor. The unstandardized coefficient for daily work hours is 5.877, with a standard error of 0.860. For each additional hour worked, the development of CTS is expected to increase by 5.877 units, holding other factors constant. Also, according to the study of International Information and Engineering Technology Association (2022) prolonged hours of riding can lead to various health issues, particularly musculoskeletal disorders (MSDs). The p-value is <0.001 which is lower than 0.05 significance level, thus we reject Ho which implies that daily work hours is a highly significant predictor in the development of CTS.

Table 4. Linear regression on result of age and CTS

Independent Variable	Dependent Variable	Beta	Std. Error	p-value	Decision	Conclusion
Age	Carpal Tunnel Syndrome	3.051	.979	.002	Reject Ho	Significant

Note: Unstandardized coefficient

Table 4 provides results from a linear regression analysis with the development of CTS as the dependent variable and Age as the predictor. The unstandardized coefficient for Age is 3.051, with a standard error of 0.979 which implies that for each additional year of age, the development of CTS is expected to increase by 3.051 units, assuming other factors remain constant. Since the p- value is less than the 0.05 significance level, then we reject the Ho. Also, according to Steinberg (2022) between the ages of 30 and 50 are the most common age group to experience carpal tunnel syndrome. Therefore, we can say that age is a significant positive predictor on the development of CTS.

CONCLUSION

This study examined the ergonomic risk factors contributing to Carpal Tunnel Syndrome (CTS) among Angkas drivers in Metro Manila, revealing it as a significant occupational health concern. The demographic data showed that most respondents were aged 31–40, with a common height of 5'6" and weight between 66–70 kg. Over 81% of drivers had more than two years of work experience, and 54.9% reported working over 10 hours daily. A majority of the drivers experienced CTS-related symptoms, such as hand pain (72.8%) and tremors (56.4%), which occurred 2–3 times per week. These symptoms were most pronounced during tasks like gripping the throttle, with varying levels of difficulty in performing job-related tasks.

The potential development of CTS among Angkas drivers mirrors findings from various studies that document the high incidence of musculoskeletal disorders (MSDs) in motorcycle taxi drivers. For instance, Khokar and Ali (2023) identified a significant 13% prevalence of CTS among motorcycle drivers, aligning with the results of this study that show a high rate of pain and discomfort among Angkas drivers, this means that most angkas drivers in Metro Manila are potentially developing CTS. The repetitive nature of tasks such as gripping the throttle and maintaining posture while driving is

a shared factor between their study and the current one. This correlates with the work of Utami (2023), who also found that repetitive wrist motions from prolonged throttle use are significant contributors to CTS in motorcycle riders, reinforcing the ergonomic risks faced by Angkas drivers.

Furthermore, the study's findings that work experience, weight, and daily work hours significantly contribute to CTS development are consistent with the literature. For instance, the study by Chen et al. (2023) showed that individuals with higher BMI had a double increased risk of developing CTS, which directly correlates with the present study's findings linking weight to CTS risk. This supports the concept that BMI is a significant factor in the development of musculoskeletal disorders, as highlighted by Woolley et al. (2019), who noted that higher BMI could exacerbate the risk of MSDs such as CTS. In addition, longer working hours, which were reported to increase CTS symptoms in this study, are consistent with the findings of the International Information and Engineering Technology Association (2022), which showed that motorcycle taxi drivers commonly work long shifts, heightening the risk of occupational disorders.

Theoretical frameworks also provide important insights into the study's findings. The Biomechanical Stress Theory, as outlined by Marras and Karwowski (2006), explains how prolonged exposure to biomechanical stress from tasks like gripping handlebars and repetitive wrist movements can lead to MSDs, including CTS. This aligns with the studies finding that drivers who work longer hours and engage in repetitive tasks are at a higher risk of developing CTS.

In conclusion, this study's results reinforce the findings from existing literature, indicating that prolonged exposure to ergonomic risks, such as repetitive motions, awkward postures, and long work hours, including the ergonomic factors such as Age, Height, and Weight significantly contributes to the high development of CTS among Angkas motorcycle taxi drivers. The study highlights the need for practical ergonomic solutions, optimized work schedules, and regular health monitoring, to reduce the strain on drivers and prevent further complications. These recommendations align with the work of Public Health Tulane (2023) and Kiran (2020), who emphasize the importance of optimized working schedules in preventing MSDs and improving workplace safety. By addressing these issues, Angkas can help maintain better health and well-being for its drivers, ensuring long-term occupational sustainability and safety. (Parker et al., 2017).

REFERENCES

A Step-by-Step Guide Rapid Upper Limb Assessment (RULA). (n.d.). https://ergo-plus.com/wp- content/uploads/RULA-A-Step-by-Step-Guide1.pdf

Aboonq, M. S. (2015). Pathophysiology of carpal tunnel syndrome. *Neurosciences (Riyadh, Saudi Arabia)*, *20*(1), 4–9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4727604/#:~:text=Carpal%20tunnel%20syndrome%20(CTS)%20is%20a%20neuropathy%20caused%20by%20compression

Adebayo, P., Mwakabatika, R. E., Mugisha Clement Mazoko, Taiwo, F. T., Ali, A. J., & Ali Akbar Zehri. (2020). *Relationship Between Obesity and Severity of Carpal Tunnel Syndrome in Tanzania*. *18*(10), 485–492. https://doi.org/10.1089/met.2020.0062

American Heart Association. (2024). *Body Mass Index (BMI) In Adults*. Www.heart.org. https://www.heart.org/en/healthy-living/healthy-eating/losing-weight/bmi-in-adults

Carpal tunnel syndrome - Symptoms and causes. (2024). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/carpal-tunnel-syndrome/symptoms-causes/syc-20355603#:~:text=The%20carpal%20tunnel%20is%20a

Castro, A. F., & Aliakbar Akbaritabar. (2024). The use of linear models in quantitative research. *Quantitative Science Studies*, 1–32. https://doi.org/10.1162/qss_a_00294

Chen, J.-Q., Wang, D., & Liu, B. (2023). Body mass index and carpal tunnel syndrome: A case- control study. *Medicine (Baltimore, Md.)*, *102*(31), e34468–e34468. https://doi.org/10.1097/md.0000000000034468

Ciampa, J. (2021, March 9). *What is Ergonomics?* LightGuide. https:// http://www.lightguidesys.com/resource-center/blog/what-is-ergonomics/

Divincenzo, K. (2021). *What You Need To Know About The National Institute of Occupational Safety and Health (NIOSH)*. Www.work-Fit.com. https://www.work-fit.com/blog/what-you- need-to-know-about-the-national-institute-of-occupational-safety-and-health-niosh

Dutta, K., Basu, B., & Sen, D. (2018). Evaluation of postural, psychosocial stress and driver behaviour of motorbike riders in India. *Occupational Ergonomics*, *13*, 25–36. https://doi.org/10.3233/oer-170251

Green, L. (2019). *Occupational Safety And Health Act* . Investopedia. https://www.investopedia.com/terms/o/occupational-safety-and-health-act.asp

GRIEVE, D. (1998). Fitting the Task to the Human: A Textbook of Occupational Ergonomics, 5th edn. By K. H. E. Kroemer and E. Grandjean. (Pp x+416; illustrated; f16.95 paperback; ISBN 0 7484 0665 4.) London: Taylor & Francis. 1997. *Journal of Anatomy*, *192*(3), 473–476. https://doi.org/10.1046/j.1469-7580.1998.192304733.x

kanade, vijay. (2023, April 3). *What Is Linear Regression? Types, Equation, Examples, and Best Practices for 2022*. Spiceworks. https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-linear-regression/

Kee, D. (2022). Systematic Comparison of OWAS, RULA, and REBA Based on a Literature Review. *International Journal of Environmental Research and Public Health*, *19*(1), 595. https://doi.org/10.3390/ijerph19010595

Kenton, W. (2024, February 26). *Analysis of variance - ANOVA*. Investopedia. https://www.investopedia.com/terms/a/anova.asp

Khokhar, A. M., Ali, M. M., & Raza, M. M. (2023). Carpal Tunnel Syndrome in Motorbike Riders: Prevalence, Severity, and Implications for Occupational Health: Carpal Tunnel Syndrome in Motorbike Riders. *Pakistan BioMedical Journal*, 30–34. https://doi.org/10.54393/pbmj.v6i11.967

Kiran, D. (2020). *Ergonomics - an overview | ScienceDirect Topics*. Www.sciencedirect.com. https://www.sciencedirect.com/topics/engineering/ergonomics

Laboratory Safety Programs | National Institute of Safety and Health (NIOSH). (2023). National Institute of Justice. https://nij.ojp.gov/nij-hosted-online-training-courses/laboratory-safety- programs/safety-requirements/national-institute-safety-and-health-niosh

Machado Sanchez, H., Gouveia de Morais Sanchez, E., Alves Barbosa, M., Celeno Porto, C., & Silva Approbato, M. (2019). Comparison of Quality of Life and Work Ability of Taxi and Motorcycle Taxi Drivers: Evidence from Brazil.

International Journal of Environmental Research and Public Health, *16*(4), 666. https://doi.org/10.3390/ijerph16040666

Marras, W. & Karwowski, W. (2006). Interventions, controls, and applications in occupational ergonomics the occupational ergonomics handbook, second edition. *Retrieved from* https://www.researchgate.net/publication/329236831_Interventions_controls_and_applications_in_occupational_ergonomics_the_occupational_ergonomics_handbook_second_edition

Middlesworth, M. (2019, March 7). *Ergonomics 101: The Definition, Domains, and Applications of Ergonomics*. ErgoPlus. https://ergo-plus.com/ergonomics-definition-domains-applications/

mrandmrshowe. (2021, August 13). *How to Apply for Angkas Rider*. Mr&MrsHowe | Travel, Lifestyle & Coaching by Kach Howe. https://mrandmrshowe.com/lifestyle-blog/how-to-apply- angkas-rider-philippines

Steinberg, D. (2022). *Carpal Tunnel Syndrome - Musculoskeletal and Connective Tissue Disorders*. MSD Manual Professional Edition. https://www.msdmanuals.com/professional/musculoskeletal-and-connective-tissue- disorders/hand-disorders/carpal-tunnel-syndrome

Tantawy, S. A., Abdul Rahman, A., & Abdul Ameer, M. (2017). The relationship between the development of musculoskeletal disorders, body mass index, and academic stress in Bahraini University students. *The Korean Journal of Pain*, *30*(2), 126–133. https://doi.org/10.3344/kjp.2017.30.2.126

Thamrin, Y., Pasinringi, S., Darwis, A. M., & Putra, I. S. (2021). Relation of body mass index and work posture to musculoskeletal disorders among fishermen. *Gaceta Sanitaria*, *35*, S79– S82. https://doi.org/10.1016/j.gaceta.2020.12.022

Titis Mariyamah, Yusuf Handoko, Eliana, M., & Susanty Dewi Winata. (2024). The Carpal Tunnel Syndrome and Ergonomic Risk Factor Profile in Online Motorcycle Taxi Drivers (*ojol*) in Jakarta. *SHS Web of Conferences*, *189*, 01047–01047. https://doi.org/10.1051/shsconf/202418901047

Utami, K. P. (2023). *ORCID*. Orcid.org. https://orcid.org/0000-0003-3493-2677

Woolley, C., Thompson, C., Hakendorf, P., & Horwood, C. (2019). The Effect of Age upon the Interrelationship of BMI and Inpatient Health Outcomes. *The Journal of Nutrition, Health & Aging*, *23*(6), 558–563. https://doi.org/10.1007/s12603-019-1206-x

Workplace Ergonomics Safety: Tips, Equipment, and Examples. (2023, June 9). Publichealth.tulane.edu. https://publichealth.tulane.edu/blog/workplace-ergonomics-safety/