Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA
Published: April 8, 2025
DOI: 10.46254/AF6.20250100

Assessment of Risk Factors of Musculoskeletal Disorder Among Occupational Motorcyclists Under Ride-Hailing Applications in Metro Manila

Professor Carlos Ignacio Lugay Jr., PhD, PIE, ASEAN Engr.
Research Adviser and Co-Author
Department of Industrial Engineering
University of Santo Tomas-Manila
Sampaloc, Manila
Philippines
cplugay@ust.edu.ph

Althea Laicy Cruz, Pearl Rose Eras, Marc Francis Imperial and Ralph Gabriel Sauco
Student, Bachelor of Science in Industrial Engineering
University of Santo Tomas-Manila
Sampaloc, Manila
Philippines
althealaicy.cruz.eng@ust.edu.ph, pearlrose.eras.eng@ust.edu.ph
marcfrancis.imperial.eng@ust.edu.ph
ralphgabriel.sauco.eng@ust.edu.ph

Abstract

With the rise of diverse transportation options worldwide, companies now consider various factors in mobility and delivery. Motorcycle taxis have become widely available and are rapidly transforming the transportation scene in the Philippines. Due to increasing commuter demand, tens of thousands of additional ride-hailing motorcyclists are needed, leading to continuous growth in this sector. Despite its expansion, a significant research gap exists. Most studies focus on risk factors without incorporating "pain level" as a measure for identifying musculoskeletal disorders (MSDs) among ride-hailing motorcyclists. This study addresses that gap by examining the correlation between risk factors and the pain levels of MSDs among ride-hailing motorcyclists in the Philippines. The primary objective is to determine the significant risk factors influencing MSD-related pain. The research focuses on male ride-hailing motorcyclists aged 21–55 in Metro Manila, utilizing surveys, interviews, and observations for data collection. Multiple linear regression analysis with "pain level" as the dependent variable is employed. Findings indicate that weight, alcohol consumption, motorcycle vibration, and riding duration significantly impact MSD-related pain levels. These factors contribute to work-related musculoskeletal disorders (WMSDs) among ride-hailing motorcyclists. To mitigate risks, the study recommends careful monitoring of rider weight, reducing alcohol intake, regular motorcycle maintenance, and limiting travel to 7–9 hours per day to minimize fatigue. Addressing these factors can improve rider well-being and work efficiency, reducing the prevalence of WMSDs among motorcycle taxi drivers in the Philippines.

Keywords
Work-related Musculoskeletal Disorders (MSDs), Ride-hailing occupational motorcyclists, Risk factors, Pain level, Multiple linear regression (MLR).

1. Introduction
With the rise of different transportation modalities worldwide, companies have gained the ability to consider different aspects of moving or delivering. Motorcycle taxis have been widely available to consumers and are slowly taking over the transportation scene in the Philippines with ease. The country needs an additional tens of thousands of ride-hailing motorcyclists to meet the demand of commuters, due to this, the number of motorcycle taxi riders is continuously increasing, and according to a news article by Rappler (2023), at least 100,000 motorcycle taxi riders needed for industry. To be able to provide for their families, these ride-hailing motorcyclists ignore the innate risks of the venture. About 70% of traffic-related incidents in the country involve injured motorcyclists, also claiming 50% of road deaths (Amisola, 2020). In turn, this meant the question of safety and reliability with the growing uncertainty on the viability of motorbiking as a commute alternative in the first place.

Work-related Musculoskeletal disorders (WMSDs) are injuries from working brought by sudden or sustained exposure to repetitive movements, force, vibration, and awkward positions. The most commonly affected body regions among motorcyclists are the lower back, neck, shoulder, upper back, hips, thighs, and buttocks (Hafzi et al. 2011). Overall, WMSDs commonly experienced by motorcycle riders include lower back pain, neck and shoulder pain, wrist and hand pain, and hip and knee strain, along with vibration-related injuries eventually leading to Hand-Arm Vibration Syndrome (HAVS).

Accordingly, the research would be vital to improving the health quality and working experience of the increasing number of riders who have ride-hailing applications as their daily source of income. The results identified and analyzed the various risk factors contributing to WMSDs among ride-hailing motorcyclists, aiming to devise effective strategies and provide recommendations to mitigate or eliminate these risks. Lastly, there remains a significant gap in the literature, as existing studies are predominantly focused on the prevalence of risk factors and do not include the variable “pain level” as the method of identifying existing Musculoskeletal Disorders (MSDs) of ride-hailing motorcyclists.

1.1 Objectives
The main objective of the study is to determine the significant risk factors that influence the pain levels of Musculoskeletal Disorders (MSDs) experienced by ride-hailing motorcyclists. The study also developed recommendations to mitigate or eliminate these risks. In addition, the research aims to address the following specific objectives: 1.) To determine the risk factors that influence the pain levels of MSDs experienced by ride-hailing motorcyclists through the review of related literature. 2.) Utilize MLR in the analysis of the gathered data. 3.) To determine the relationships between the identified risk factors and the pain levels experienced by the rider. 4.) Develop recommendations to mitigate or eliminate the identified significant risk factors.

2. Literature Review
In response to the Philippines' growing transportation demands, commuters increasingly rely on Transport Network Vehicle Service (TNVS) apps, also known as "app-based ride-hailing services," as a convenient means of travel (Gumasing et al. 2023). Along with this surge, a significant number of individuals are exposed to prolonged periods of discomfort while riding motorcycles (Arunachalam et al. 2021). Previous research on motorcycle ergonomics provides a foundation for understanding the potential risk factors contributing to musculoskeletal disorders (MSDs) among motorcycle riders exposed to extended riding durations (Anoop & Binoosh 2019; Arunachalam et al. 2021).

The detrimental effects of prolonged static sitting have been highlighted as a major contributor to MSDs, leading to muscle stiffness, reduced blood flow, discomfort, distress, and fatigue (Tony et al. 2020). Despite concerns about motorcycle riders acquiring MSDs due to prolonged riding durations, recent studies suggest that MSDs remain an overlooked area of research among motorcycle riders despite the large population of two-wheeler riders and

passengers (Ospina-Mateus et al. 2019; Diyana et al. 2019; Arunachalam et al. 2021). Due to limited research, identifying MSDs among motorcycle riders has been challenging (Ullah et al. 2022).

Studies focusing on ergonomic interventions emphasize the importance of posture improvements in mitigating MSD risks. Hutabarat et al. (2022) conducted research among 30 drivers in Malang District, Indonesia, across three types of motorcycles, integrating Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) methodologies to address ergonomic concerns. The study proposed adjustments to body angles and positions, including neck, back, leg, arm, and wrist positioning, to reduce muscle tension and prevent discomfort. Recommendations included maintaining neck angles within 0-20 degrees, aligning back posture at 0-20 degrees, adjusting seat height, positioning legs forward, maintaining relaxed arm positions, and ensuring wrist angles of 15 degrees (Hutabarat et al. 2022). Salunkhe et al. (2022) suggest interventions such as educating riders on correct posture, increasing physical activity, performing back stretches, and ergonomically redesigning handles and seating.

MSDs manifest in various body parts, with lower back pain (LBP) being the most frequently reported, followed by upper back pain (UBP), shoulder pain, and neck pain (Anoop & Binoosh, 2019; Initia et al. 2022; Morken et al. 2007; Larsen, 2018). Biomechanical factors such as joint angles, stress, postures, muscular contractions, force exertion, and pressure distribution while seated contribute to these disorders (Ullah et al. 2022; Initia et al. 2022; Lugay & Matias, 2015). Common MSDs include trunk strain, neck and shoulder pain, wrist and hand pain, and hip and knee strain, which may have long-term repercussions for rider well-being. Improper riding posture has also been identified as a significant contributor to MSD risk factors in the spine, shoulders, and arms (Arunachalam et al. 2021). While less prominent, some discomfort is also reported in the hips, knees, and feet (Larsen 2018; Morken et al. 2007). LBP remains widespread, often exacerbated by extended riding durations (Sultan et al. 2022; Memon et al. 2019).

Physical characteristics such as anthropometrics, age, gender, riding experience, years of usage, and duration play a role in determining riding posture (Arunachalam et al. 2019; Initia et al. 2022; Lugay & Matias 2015; Morken 2007; Hutabarat 2022). Age is consistently identified as a risk factor for developing MSDs, attributed to biological fatigue during riding (Haworth 2006; Alias et al. 2016). Variations in body dimensions, such as height and weight, contribute to MSDs, often leading to discomfort and pain that may escalate into serious musculoskeletal issues (Hutabarat 2022; Initia et al. 2022).

Personal behaviors significantly correlate with posture health risks. Singh et al. (2023) found that alcohol consumption, particularly while driving, increases health risks such as severe injuries, body aches, fatigue, LBP, neck pain, and MSDs. Hafzi et al. (2011) identified smoking as a factor associated with a high prevalence of MSDs in motorcyclists. Ekpenyong and Inyang (2014) suggested that integrating physical activities into riders' lifestyles reduces WMSD risks by enhancing joint function and blood circulation.

Occupational motorcyclists face an elevated risk of work-related musculoskeletal disorders (WMSDs) due to work behaviors. Mirbod et al. (1997) found that prolonged riding durations, especially beyond five hours per day, significantly contribute to WMSDs. Anoop and Binoosh (2019) warned against extended static postures that restrict blood flow and lead to muscle stiffness. Njaka et al. (2023) identified frequent, repetitive work activities and awkward occupational postures as causes of painful tendon, muscle, and ligament disorders, ultimately leading to WMSDs. Motorcycle riders frequently experience fatigue in the forearm, mid-back, and lower back muscles, with upright postures causing more fatigue than leaning-forward postures on rural roads (Ospina-Mateus et al. 2019). MSD-related discomfort negatively impacts rider performance, including concentration, cognitive capacity, mobility, and stamina (Gumasing & Sanchez 2023).

Riders are also susceptible to environmental factors, with temperature and vibrations posing significant risks (Anoop & Binoosh 2019; Lugay & Matias 2015; Bovenzi 2006; Alias et al. 2016). Tony et al. (2020) found that riders maintain posture primarily through lower back muscles, which absorb vibrations from the road. These vibrations, known as

whole-body vibrations (WBV), are predominantly vertical and significantly impact the human body, highlighting the need for ergonomic considerations in motorcycle design to improve rider health and comfort.

Addressing discomfort among motorcycle riders requires considerations of both posture and seating design (Pratiwi et al. 2024). Motorcycle design factors, such as seat height, angles, handlebars, and footrest height, significantly influence rider posture (Ospina-Mateus et al. 2019). Badrulhisyam et al. (2020) proposed using lumbar support to minimize discomfort levels and improve ergonomic seat design. Hutabarat et al. (2022) also recommended improving motorcycle dimensions, including seat height, width, and handlebar dimensions, to enhance rider comfort and safety.

Additionally, Ahmad et al. (2023) observed a high prevalence of motorcycle riders seeking medical attention and requiring medication to manage MSDs, leading to psychological distress and financial strain for affected individuals while also burdening public health, health insurance programs, businesses, and workers. Addressing MSDs among occupational motorcyclists is crucial, given their broader societal health and economic implications (Li et al. 2022)

The literature underscores the heightened risk of musculoskeletal disorders (MSDs) among occupational motorcyclists due to prolonged riding durations, improper posture, and biomechanical stressors. Lower back pain (LBP) is the most frequently reported condition, followed by neck, shoulders, and upper back discomfort. Contributing factors include riding posture, motorcycle ergonomics, physical characteristics, and personal behaviors, with environmental factors such as whole-body vibrations further exacerbating these issues. Research highlights the necessity of ergonomic interventions, including posture education, seat modifications, and lifestyle adjustments, to mitigate MSD risks. Addressing these concerns is critical, as MSDs not only affect rider health and performance but also impose significant economic and public health burdens.

3. Methods

The study utilized a correlation type of research design to determine the relationship between the significant risk factors and the pain level experienced by the riders. The ten (10) predetermined risk factors: age, height and weight, smoking and drinking habits, posture, frequency and duration of riding, vibration of motorcycle, and the engagement in physical exercises of the riders are adapted from previous related studies. To quantify the rider's overall “Pain Level”, the dependent variable in this study, the values are calculated by summing the products of the frequency and severity of pain reported by the rider across all body areas. This approach provides a single quantitative measure of the rider’s pain experienced.

The risk factors: age, height, weight, smoking and drinking habits, riding frequency and duration, motorcycle vibration, and engagement in physical exercise are measured using a carefully constructed questionnaire to quantify the data for analysis. Posture, another risk factor, is assessed through a Rapid Entire Body Assessment (REBA) to determine the rider’s posture score. To quantify the rider's overall “Pain Level,” the dependent variable in this study, the values are calculated by summing the products of the frequency and severity of pain reported across all body areas. This approach provides a single quantitative measure of the rider’s pain, enabling the use of Multiple Linear Regression (MLR) to identify significant risk factors influencing pain levels.

Data gathering through interviews and direct observation was accomplished to measure information regarding personal demographics, risk factors, and the pain levels experienced by the riders in terms of frequency and severity rates. The gathered data underwent thorough analysis using MLR done through the SPSS software. MLR is utilized to examine the correlations between dependent and independent variables and identify the significant variables in the regression model to understand further the relationship of the identified significant risk factors with the pain level of WMSDs experienced by the riders. In conducting MLR, the proponents ensured that all assumptions were met to produce reliable and valid results.

4. Data Collection

The study’s required sample size of 118 was calculated using G*Power software, considering effect size, alpha error probability, statistical power, and the number of predictors due to the lack of population data for occupational motorcyclists in ride-hailing applications. The study focused on male occupational motorcyclists under ride-hailing

application companies who have been working for at least 6 months, aged between 21 and 55, located within Metro Manila whose musculoskeletal disorders are work-related. The study concentrated on male riders, reflecting the predominant gender demographic among riders. Metro Manila was chosen due to its status as the primary area of operation for ride-hailing applications, reflecting the service's high usage and relevance in this region. Occupational motorcyclists from all ride-hailing applications such as Angkas, Joyride, and Move It would be considered as there are no significant differences between how these applications work and provide their services.

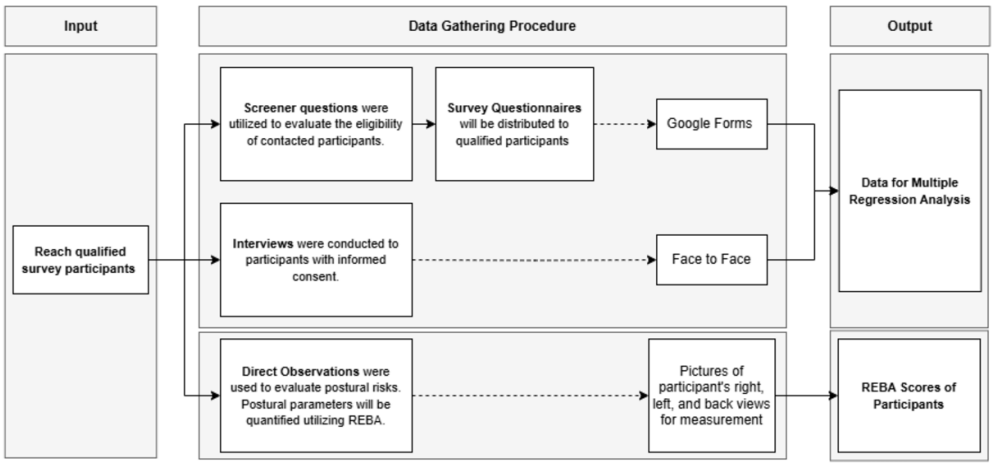

Figure 1. Data Gathering Flowchart

For the data collection process, the researchers conducted full face-to-face surveys and direct observations. Before administering the survey, the respondents had to answer a screener questionnaire to confirm whether any musculoskeletal disorders reported by participants were related to their work. After ensuring the qualifications of the participant, the main survey was conducted to measure essential information regarding personal demographics (including age, body measurements, and smoking and drinking habits), physical risk factors (such as vibration and frequency and duration of riding), non-occupational factors (such as engagement in physical exercises), and the frequency and severity rates of pain experienced by the riders. Direct observations were carried out to evaluate the postural risks associated with motorcycle riding. The static dimensions of the rider's posture were measured using the Rapid Entire Body Assessment (REBA) to assess postural risks associated with motorcycle riding through direct observations, providing valuable insights into ergonomics and potential areas for intervention or improvement.

5. Results and Discussion

5.1 Numerical Results

Multiple logistic regression (MLR) is a statistical method used to analyze the significant relationships between a continuous dependent variable (pain level) and multiple determined independent variables (risk factors). It is crucial to adhere to the assumptions of MLR to ensure that the results are valid and reliable. If these assumptions are not met, the data should be re-evaluated, and additional steps may be necessary to meet the requirements of the statistical model. This chapter contains the numerical results that serve as evidence of the compliance of the collected data with the assumptions as well as the MLR results obtained using the SPSS software.

Assumption of Linearity

Table 1. Multiple Correlation Coefficient (R-value)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.758[a]	.575	.535	11.91209

a. Predictors: (Constant), Physical, Duration, Posture, Frequency, Height, Drinking, Smoking, Vibration, Age, Weight

The R-value reflects the predictive quality for the dependent variable, with values approaching 1 indicating greater accuracy. In this instance, an R-value of 0.758 falls within the strong positive association range (between +0.6 and +0.8), which indicates a solid level of linear relationship, thus complying with the assumption.

Assumption of Independent Errors and Homoscedasticity

Table 2. Durbin-Watson Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.758[a]	.575	.535	11.91209	1.527

a. Predictors: (Constant), Physical, Duration, Posture, Frequency, Height, Drinking, Smoking, Vibration, Age, Weight

b. Dependent Variable: Pain

The R-squared value denotes the extent to which the independent variable accounts for the variability observed in the dependent variable. Specifically, this indicates that the independent variable explains 57.5% of the variation in pain levels. As a reference, according to the Munich Personal Archive, an R-square value ranging between 0.50 to 0.99 is considered acceptable in conducting MLR.

The computed value for the Durbin-Watson test is 1.527 which is within the acceptable range (between 1.50 and 2.00). This indicates that there is no first-order autocorrelation between the data thereby complying with the assumption of independent errors and homoscedasticity.

Assumption of No Multicollinearity

Table 3. Pearson Correlation

Correlations

		Pain	Age	Height	Weight	Smoking	Drinking	Posture	Vibration	Frequency	Duration	Physical
Pearson Correlation	Pain	1.000	.010	-.106	.308	.094	.248	-.073	.315	-.031	.694	-.045
	Age	.010	1.000	.037	-.004	-.069	-.095	-.036	.041	.117	-.068	-.370
	Height	-.106	.037	1.000	.510	.034	-.120	.016	-.022	.016	-.180	.013
	Weight	.308	-.004	.510	1.000	.110	-.116	-.057	.063	-.145	.233	-.028
	Smoking	.094	-.069	.034	.110	1.000	.155	-.100	.073	.096	.089	-.176
	Drinking	.248	-.095	-.120	-.116	.155	1.000	.021	.197	.092	.152	-.040
	Posture	-.073	-.036	.016	-.057	-.100	.021	1.000	-.043	.049	-.064	.049
	Vibration	.315	.041	-.022	.063	.073	.197	-.043	1.000	-.119	.187	-.063
	Frequency	-.031	.117	.016	-.145	.096	.092	.049	-.119	1.000	-.118	-.027
	Duration	.694	-.068	-.180	.233	.089	.152	-.064	.187	-.118	1.000	-.008
	Physical	-.045	-.370	.013	-.028	-.176	-.040	.049	-.063	-.027	-.008	1.000

The independent variables must not be correlated with each other, a condition known as multicollinearity. This can be assessed through correlation matrices where correlation coefficients should ideally be below 0.80. Present in the figure above is the correlation matrix including all the independent variables of the study. It can be observed from the matrix that there are no values greater than 0.80, therefore the data does not exhibit multicollinearity.

Table 4. Variance Inflation Factor (VIF)

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.319	30.651		.043	.966					
	Age	.098	.137	.050	.719	.474	.010	.069	.045	.813	1.231
	Height	-.266	.189	-.111	-1.404	.163	-.106	-.134	-.089	.639	1.565
	Weight	.387	.126	.250	3.075	.003	.308	.285	.194	.601	1.665
	Smoking	-.108	.342	-.021	-.317	.752	.094	-.031	-.020	.892	1.121
	Drinking	3.275	1.524	.145	2.149	.034	.248	.203	.135	.879	1.138
	Posture	-.369	1.192	-.020	-.310	.757	-.073	-.030	-.020	.978	1.023
	Vibration	4.040	1.587	.168	2.546	.012	.315	.239	.161	.911	1.098
	Frequency	2.181	1.820	.079	1.199	.233	-.031	.115	.076	.911	1.098
	Duration	3.224	.400	.576	8.066	.000	.694	.615	.509	.781	1.281
	Physical	.040	1.281	.002	.031	.975	-.045	.003	.002	.817	1.225

a. Dependent Variable: Pain

VIF values that are above 4 or below 0.25 indicate that multicollinearity might exist. Based on the computed VIF of the data, the results are less than 4 and the average VIF is not substantially greater than 1 (CFI Team, 2024). Therefore, the data does not exhibit multicollinearity.

Assumption of Normally Distributed Errors

Table 5. Kolmogorov-Smirnov and Shapiro-Wilk

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Standardized Residual	.075	118	.095	.982	118	.122

a. Lilliefors Significance Correction

The results of the Kolmogorov-Smirnov test (p-value = 0.095) and the Shapiro-Wilk test (p-value = 0.122) both show p-values greater than the significance level $\alpha = 0.05$. Since both p-values exceed 0.05, we fail to reject the null hypothesis, which states that the residuals follow a normal distribution. Therefore, the residuals can be considered normally distributed, satisfying the assumption of normality.

Multiple Linear Regression Results

Table 6. Multiple Linear Regression Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients			Correlations			Collinearity Statistics	
		B	Std. Error	Beta	t	Sig.	Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	1.319	30.651		.043	.966					
	Age	.098	.137	.050	.719	.474	.010	.069	.045	.813	1.231
	Height	-.266	.189	-.111	-1.404	.163	-.106	-.134	-.089	.639	1.565
	Weight	.387	.126	.250	3.075	.003	.308	.285	.194	.601	1.665
	Smoking	-.108	.342	-.021	-.317	.752	.094	-.031	-.020	.892	1.121
	Drinking	3.275	1.524	.145	2.149	.034	.248	.203	.135	.879	1.138
	Posture	-.369	1.192	-.020	-.310	.757	-.073	-.030	-.020	.978	1.023
	Vibration	4.040	1.587	.168	2.546	.012	.315	.239	.161	.911	1.098
	Frequency	2.181	1.820	.079	1.199	.233	-.031	.115	.076	.911	1.098
	Duration	3.224	.400	.576	8.066	.000	.694	.615	.509	.781	1.281
	Physical	.040	1.281	.002	.031	.975	-.045	.003	.002	.817	1.225

a. Dependent Variable: Pain

Employing SPSS software to examine the correlations between dependent and independent variables via multiple linear regression (MLR), the p-value of each independent variable must be below 0.05 to qualify as significant. The results reveal that age (p-value = 0.474), height (p-value = 0.163), smoking habits (p-value = 0.752), posture (p-value = 0.757), frequency of riding (p-value = 0.233), and participation in physical exercise (p-value = 0.975) do not have a significant impact on work-related pain levels associated with motorcycle ride-hailing experiences.In contrast, the remaining four variables—the weight of the rider, drinking habits, motorcycle vibration, and duration of riding—exhibit p-values that are less than 0.05. This statistical significance suggests that these variables have a considerable impact on the pain levels associated with musculoskeletal disorders (MSD) experienced by riders.

5.2 Graphical Results

In addition to the numerical results presented in Chapter 5.1, the following graphical results further explain and prove the compliance of the collected data with the assumptions of MLR:

Assumption of Linearity

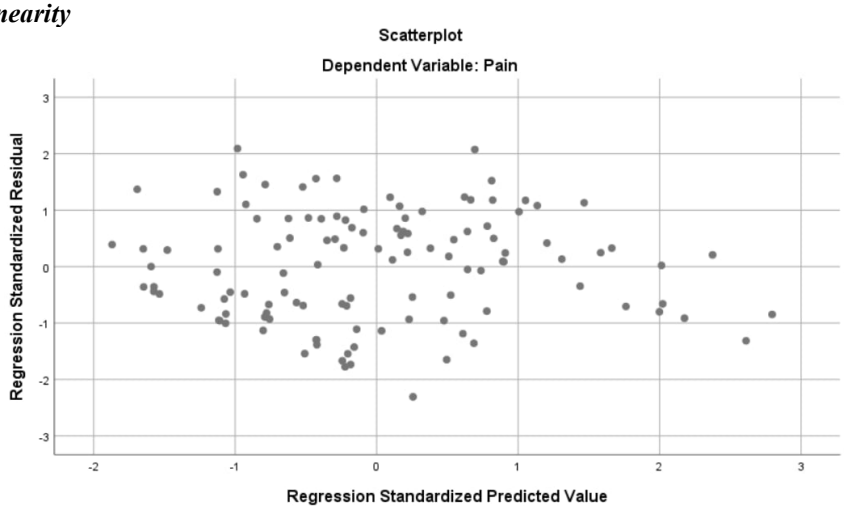

Figure 2. Scatterplot

Included in the assumptions of MLR is that a linear relationship exists between the dependent and the independent variables. This linearity can be visually assessed using scatterplots, which should display a well-spread pattern rather than a curvilinear one.

Assumption of Normally Distributed Errors

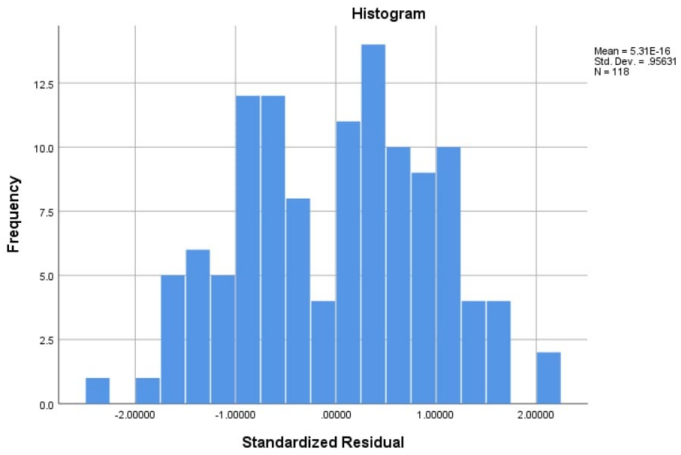

Figure 3. Histogram of Residuals

Another method of assessing the normality of the residuals of the data is through histograms. If the histogram shows a bell-shaped curve, it denotes that the errors in the data are normally distributed.

5.3 Proposed Improvements

Based on the statistical analysis of identified risk factors, it is recommended to regulate rider weight, alcohol consumption, motorcycle vibrations, and ride duration to minimize the risk of work-related musculoskeletal disorders (MSDs) among moto-taxi riders. Maintaining a healthy weight is essential, as increased body weight has been shown to increase pressure on joints and muscles, leading to higher pain levels and a greater likelihood of developing MSDs (Arunachalam et al., 2021). Reducing alcohol consumption is crucial, as alcohol not only exacerbates muscle pain but also impairs recovery, prolonging muscle strain and discomfort.

Furthermore, regular motorcycle maintenance—such as oil changes, valve adjustments, and chain lubrication—helps to minimize excessive vibrations, which are a known contributor to musculoskeletal damage. By addressing motorcycle vibrations, riders can experience reduced physical strain, which lowers the risk of developing MSDs over time (MotoDeal, 2021).

In addition to these technical measures, ride-hailing companies should implement proactive health support initiatives to directly target the prevention of MSDs. These could include biannual medical check-ups, proper posture and muscle care education, and incentive-based programs encouraging riders to participate in health-focused activities. Such programs would not only reduce the impact of physical stress but also promote long-term well-being by addressing risk factors before they escalate into serious issues.

Establishing regulations on motorcycle lifespan is also necessary, as older motorcycles may develop mechanical issues that contribute to vibrations and instability, further increasing the risk of musculoskeletal strain (Grey, 2022). A structured reward and penalty system for proper motorcycle maintenance, coupled with passenger feedback to ensure compliance, could incentivize riders to maintain their motorcycles in optimal condition, thus reducing the risk of vibration-related MSDs.

To further alleviate physical strain, it is recommended that moto-taxi riders limit their daily working hours to 7-9 hours and take 10-15 minute breaks every 90 minutes to support muscle recovery and prevent fatigue-related injuries (VikingBags, 2022). Enforcing strict policies on safe working hours and integrating in-app reminders for breaks can significantly reduce overexertion and promote musculoskeletal recovery. Additionally, encouraging riders to take breaks through incentives would provide an effective way to mitigate the cumulative effects of prolonged riding.

By implementing these recommendations, ride-hailing companies can help create a healthier working environment that directly correlates with a reduction in musculoskeletal disorders, leading to a more sustainable workforce and a reduction in long-term health costs.

6. Conclusion

The study aimed to identify key risk factors influencing the pain levels of Musculoskeletal Disorders (MSDs) among ride-hailing motorcyclists and develop recommendations to mitigate these risks. Through multiple linear regression analysis, it was determined that **weight, alcohol consumption, motorcycle vibration, and ride duration significantly impact the pain levels experienced by riders**, directly influencing the occurrence of work-related musculoskeletal disorders (WMSDs).

The study emphasizes the importance of assessing pain levels as a measure for identifying and addressing WMSDs in the workforce. By understanding these pain factors, solutions can be developed to improve working conditions and enhance health and safety for ride-hailing motorcyclists. The findings benefit both the ride-hailing industry and individual riders by promoting a healthier workforce, increasing ride availability, improving customer satisfaction, and fostering greater profitability. Addressing the identified risk factors ensures the prioritization of rider health, safety, and well-being, ultimately leading to solutions that reduce WMSDs and improve the overall safety and sustainability of the ride-hailing sector.

References

Ahmad, E., Daud, A., Hairon, S., Nordin, R., Azmir, N. A., and Jalil, M. A. S. M., Prevalence and impact of work-related musculoskeletal disorders among food delivery riders in Eastern Peninsular Malaysia, International Journal of Innovative Research and Scientific Studies, vol. 6, no. 3, pp. 586–593, 2023.

Alias, A. N., Karuppiah, K., Tamrin, B. M. T., Abidin, E. Z., Shafie, U. K. M., and Sambasivam, S., Risk factors of muscular discomfort among motorcyclist-review article, Iranian Journal of Public Health, vol. 45, no. 1, pp. 35–43, 2016.

Anoop, G. A. and Binoosh, S. A., A study on musculoskeletal disorders among two-wheeler riders of Kerala state in India, Kerala Technological Congress, vol. 6, pp. 411–418, 2019.

Apptopia, Angkas - Tech stack, apps, patents & trademarks, Crunchbase, Available: https://www.crunchbase.com/organization/angkas/technology, March 23, 2024.

Arunachalam, M., Mondal, C., Singh, G., and Karmakar, S., Motorcycle riding posture: A review, Measurement, vol. 134, pp. 390–399, 2019.

Arunachalam, M., Singh, A. K., and Karmakar, S., Perceived comfortable posture and optimum riding position of Indian male motorcyclists for short-duration riding of standard motorcycles, International Journal of Industrial Ergonomics, vol. 83, 103135, 2021.

Badrulhisyam, A. J., Nurhayati, M. N., AJ, R. I., and AA, N. S., Preliminary study on the ergonomic design of motorcycle seat for comfort usage, Malaysian Journal of Public Health Medicine, vol. 20, Special issue 1, pp. 231–237, 2020.

Basem, J. I., White, R. S., Chen, S. A., Mauer, E., Steinkamp, M. L., Inturrisi, C. E., and Witkin, L. R., The effect of obesity on pain severity and pain interference, Pain Management, vol. 11, no. 5, pp. 571–581, 2021.

Bikepics, Motorcycling can be hard on your body, here's why, BikePics, Available: https://bikepics.com/blog/motorcycling-can-be-hard-on-your-body/, May 2, 2023.

BMW Motorcycles, Used motorcycle lifespan | Plano, Texas, BMW Motorcycle of North Dallas, Available: https://www.bmwmotorcyclesdallas.com/blog/determining-the-life-expectancy-of-your-used-motorcycle--66185, November 29, 2023.

Bovenzi, M., Rui, F., Negro, C., D'Agostion, F., Angotzi, G., and Bianchi, S., An epidemiological study of low back pain in professional drivers, Journal of Sound and Vibration, vol. 298, pp. 514–539, 2006.

CFI Team, Variance inflation factor (VIF) - overview, formula, uses, Corporate Finance Institute, Available: https://corporatefinanceinstitute.com/resources/data-science/variance-inflation-factor-vif/, October 19, 2024.

Cuemath, Interval notation, Cuemath, Available: https://www.cuemath.com/algebra/interval-notation/, October 19, 2024.

Dalton, A., How heavy is too heavy?, White Dalton Motorcycle Solicitors, Available: https://www.whitedalton.co.uk/motorbike-blog/2019/09/how-heavy-is-too-heavy/, March 2019.

De Jesus, M. J. M., Gutierrez, A., and Muñoz, M., An analysis of the factors influencing commuter decisions in using the Angkas: Motorcycle ride booking transportation service, Philippine Transportation Journal, vol. 46, 2018.

Diyana, M. A., Karmegam, K., Shamsul, B. M. T., Irniza, R., Vivien, H., Sivasankar, S., and Kulanthayan, K. C. M., Risk factors analysis: Work-related musculoskeletal disorders among male traffic policemen using high-powered motorcycles, International Journal of Industrial Ergonomics, vol. 74, 102863, 2019.

Egli, M., Koob, G. F., and Edwards, S., Alcohol dependence as a chronic pain disorder, Neuroscience and Biobehavioral Reviews, vol. 36, pp. 2179–2192, 2012.

Ekpenyong, C. E. and Inyang, U. C., Associations between worker characteristics, workplace factors, and work-related musculoskeletal disorders: A cross-sectional study of male construction workers in Nigeria, International Journal of Occupational Safety and Ergonomics, vol. 20, no. 3, pp. 447–462, 2014.

Elite IAS, Height weight chart – ideal weight for men and women, Elite IAS, Available: https://www.eliteias.in/height-weight-chart-ideal-weight-for-men-and-women, November 19, 2024.

Grey, M. D., What is the average life expectancy of a motorcycle?, OneHowTo, Available: https://motor.onehowto.com/article/what-is-the-average-life-expectancy-of-a-motorcycle-6656.html, March 11, 2022.

Gumasing, M. J. J., Deinla, E. C. C., Espaldon, A. K. P., Jarin, D. R. I. and Mercado, N. C., The usability of transport network vehicle service apps amidst the pandemic in the Philippines: A comparison of the convenient usage of Grab, Angkas, and JoyRide, Proceedings of the 2023 5th International Conference on Management Science and Industrial Engineering, pp. 310-318, April 2023.

Gumasing, M. J. J. and Sanchez, A. A., Ergonomic risk assessment of factors affecting musculoskeletal disorder of engineering students during online setup, ResearchGate, Available:

https://www.researchgate.net/publication/372838386, July 2023.

Haworth, N. and Rowden, P., Investigation of fatigue-related motorcycle crashes – Literature review (RSD0261), Centre for Accident Research & Road Safety, Queensland University of Technology, 2006.

Hita-Gutiérrez, M., Gómez-Galán, M., Díaz-Pérez, M. and Callejón-Ferre, Á. J., An overview of REBA method applications in the world, International Journal of Environmental Research and Public Health, vol. 17, no. 8, pp. 2635, 2020. Available: https://doi.org/10.3390/ijerph17082635.

Hignett, S. and McAtamney, L., Rapid entire body assessment, Applied Ergonomics, vol. 31, no. 2, pp. 201–205, 2000. Available: https://doi.org/10.1016/S0003-6870(99)00039-3.

Hutabarat, J., Pradana, J. A., Achmadi, F. and Basuki, D. W. L., Risk of musculoskeletal disorder in the working posture of online motorcycle drivers (Case study: Drivers at Malang District), International Journal of Ergonomics, vol. 17, no. 6, pp. 843-851, 2022.

Intia, G. R., Lenon, J. C., Mitra, K. I., Añonuevo, B. A. and Ong, N. R., Musculoskeletal disorders: Associated risk factors of the laptop usage among engineering students in the University of Santo Tomas, Proceedings of the 2022 IEOM Istanbul Conference, 2022.

Jones, R. A., Lawlor, E. R., Birch, J. M., Patel, M. I., Werneck, A. O., Hoare, E. and Ahern, A. L., The impact of adult behavioural weight management interventions on mental health: A systematic review and meta-analysis, Obesity Reviews, vol. 22, no. 4, 2020. Available: https://doi.org/10.1111/obr.13150.

Laerd Statistics, How to perform a multiple regression analysis in SPSS Statistics, Laerd Statistics, Available: https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php, Retrieved: October 19, 2024.

LaRowe, L. R., Powers, J. M., Paladino, M. B. and Ditre, J. W., Pain severity and alcohol use among daily tobacco cigarette smokers, The American Journal on Addictions, 2020. Available: https://doi.org/10.1111/ajad.13003.

Li, Z., Chen, M., Huang, X. and Shi, J., Risk factors for musculoskeletal disorders among takeaway riders: Up-to-date evidence in Shanghai, China, Frontiers in Public Health, vol. 10, 988724, 2022.

Lugay, C. I. P. and Matias, A. C., Predictive models of work-related musculoskeletal disorders (WMSDs) among sewing machine operators in the garments industry, Asia Pacific Journal of Multidisciplinary Research, vol. 3, no. 1, 2015.

Miller, M. M., Allison, A., Trost, Z., De Ruddere, L., Wheelis, T., Goubert, L. and Hirsh, A. T., Differential effect of patient weight on pain-related judgements about male and female chronic low back pain patients, The Journal of Pain, vol. 19, no. 1, pp. 57–66, 2018. Available: https://doi.org/10.1016/j.jpain.2017.09.001.

Mirbod, S. M., Yoshida, H., Jamali, M., Masamura, K., Inaba, R. and Iwata, H., Assessment of hand-arm vibration exposure among traffic police motorcyclists, International Archives of Occupational and Environmental Health, vol. 70, no. 1, pp. 22–28, 1997. Available: https://doi.org/10.1007/s004200050182.

Mohammad Yusof, N., Karuppiah, K., Rasdi, I., Mohamad Jamil, P. A. S. and Md Tamrin, S., Vibration exposure and work-musculoskeletal disorders among traffic police riders in Malaysia: A review, Annals of Tropical Medicine and Public Health, 2017.

Morken, T., Magerøy, N. and Moen, B. E., Physical activity is associated with a low prevalence of musculoskeletal disorders in the Royal Norwegian Navy: A cross-sectional study, BMC Musculoskeletal Disorders, vol. 8, pp. 56, 2007. Available: https://doi.org/10.1186/1471-2474-8-56.

Patil, D. M., Bajpai, D. L. and Verma, D. P., Design and development of motorcycle seat from ergonomics point of view with vibration and discomfort analysis, 2014.

Physiopedia, Rapid entire body assessment (REBA), Physiopedia, Available: https://www.physio-pedia.com/Rapid_Entire_Body_Assessment_(REBA), Retrieved: October 19, 2024.

Punsalang, E., 5 ways to reduce motorcycle vibration, MotoDeal, Available: https://www.motodeal.com.ph/articles/motorcycle-features/5-ways-reduce-motorcycle-vibration, September 6, 2021.

Riddle, D. L. and Stratford, P. W., Body weight changes and corresponding changes in pain and function in persons with symptomatic knee osteoarthritis: A cohort study, Arthritis Care & Research, vol. 65, no. 1, pp. 15–22, 2012. Available: https://doi.org/10.1002/acr.21692.

The Correlation Coefficient (r), sph.bu.edu, April 21, 2021. Available: https://sphweb.bumc.bu.edu/otlt/MPH-Modules/PH717-QuantCore/PH717-Module9-Correlation-Regression/PH717-Module9-Correlation-Regression4.html, Retrieved: October 19, 2024.

VikingBags, How often should you take a break during a motorcycle trip, Motorcycle 101 Guides, December 23, 2022. Available: https://www.vikingbags.com/blogs/news/how-often-should-you-take-break-during-motorcycle-trip?srsltid=AfmBOopPmL1s7eVTdseYFDfFnzFnwazLQ0dOhCm75LRMab71h87zBPbL

Zale, E. L., Maisto, S. A. and Ditre, J. W., Interrelations between pain and alcohol: An integrative review, Clinical Psychology Review, vol. 37, pp. 57–71, 2015. Available: https://doi.org/10.1016/j.cpr.2015.02.005.

Zangre, A., Discrete vs. Continuous Data: What's the Difference?, G2, September 13, 2024. Available: https://www.g2.com/articles/discrete-vs-continuous-data

Biography

Althea Laicy S. Cruz is a fourth-year Industrial Engineering student at the University of Santo Tomas, currently recognized as a Dean's Lister for her academic excellence. She is a detail-oriented and enthusiastic problem solver with a strong passion for optimizing operational processes and enhancing productivity. Her educational background highlights her commitment to excellence. She graduated junior high school with honors as part of the Science Class Program at Palawan National School. She continued her studies at the University of Santo Tomas – Senior High School, specializing in the Science, Technology, Engineering, and Mathematics (STEM) track. Beyond academics, Althea is actively involved in leadership and marketing. She is the Vice President of Public Media and Communications for the Industrial Engineering Circle. She has also gained industry experience through her internship at Norde International Distributors under the Service and Customer Care Department, contributing to operational improvements and customer engagement initiatives. Her professional experience extends to marketing, having worked as a Marketing Assistant at Sushi Bimi and currently serving as a Marketing Coordinator at JIKE HK Limited.

Pearl Rose F. Eras is a high-achieving 4th-year Industrial Engineering student at the University of Santo Tomas, consistently earning Dean's List honors and on track to graduate with Latin honors. Her academic excellence is underscored by a decade of scholarship, from Pasig City Science High School to the DOST-SEI Merit Scholarship. Beyond academics, Eras has demonstrated leadership and organizational skills as a dedicated member of the UST-Industrial Engineering Club (IEC) for three years, culminating in her role as Vice President for Finance, where she successfully planned and organized five major events; she also contributed to the Operations Research Society of the Philippines as an Executive Associate in her 2nd-year level. Complementing her academic and extracurricular pursuits, Eras gained practical experience through an internship at FCU Solutions Inc., a consulting firm specializing in ISO certification, where she directly engaged with clients and diverse operational systems, and continued part-time employment there while adeptly balancing her academic workload, organizational leadership, church commitments, and family responsibilities.

Marc Francis Imperial is a fourth-year Industrial Engineering student at the University of Santo Tomas. With his wit, analytical skills, and competency, he has consistently earned a place on the dean's list and is on track to graduate with Latin honors. His academic journey is defined by a keen interest in optimizing systems, problem-solving, and applying data-driven decision-making in real-world scenarios. Aside from academics, he is an active leader in student organizations. He served on the Executive Board of the Technical Media and Documentations Department for the Industrial Engineering Circle, where he honed his leadership, communication, and technical skills. In this role, he has contributed documentation, event coordination, and digital content creation, helping the organization's activities. He is passionate about the logistics industry, recognizing its crucial role in global commerce and supply chain management. To gain firsthand experience, he applied and completed an internship at Boxed Up Logistics, a freight forwarding company specializing in shipments from China to the Philippines. Through this experience, he developed a deeper understanding of logistics operations, shipment tracking, and client relations, further solidifying his aspiration to pursue a career in this field.

Ralph Gabriel Sauco is a fourth-year Industrial Engineering student at the University of Santo Tomas-Manila. He has been a Department of Science and Technology (DOST) RA 7687 Scholar for four years, consistently maintains dean's list status, and is on track to graduate as Magna Cum Laude. Ralph interned at Goldilocks Bakeshop, Incorporated, initially in the safety department and later in the systems improvement department, focusing on system automation projects. During his internship, he contributed to two key projects: a HIRAC project for ISO:9001 compliance and a time and motion study of the mamon production line for a new custom production machine. He has a strong interest in quality and ergonomics. Beyond academics, Ralph is the Director for Logistics at the Operations Research Society of the Philippines-UST Chapter and an Executive Associate under the Technical, Media, and Documentations Department for the Industrial Engineering Circle.