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Determining the Risk Factors Affecting Work-Related Musculoskeletal Disorders Among Street Sweepers in Quezon City, Philippines

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Abstract

Street sweepers are known to experience high levels of musculoskeletal disorders (MSDs) due to the physically demanding nature of their work. This study aimed to identify the risk factors affecting work-related musculoskeletal disorders (WMSDs) among street sweepers in Quezon City, Philippines. The researchers investigated various demographic (age, gender, occupational seniority), individual-related (BMI, drinking habits, smoking habits), work-related (work duration, work posture, work tools), and environmental (heat exposure, noise exposure) factors. A total of 130 participants were included in the study, exceeding the required sample size of 123. Quantitative research methods were utilized, with data collected using the MSD Severity and Frequency Questionnaire (MSFQ) and a researcher-administered questionnaire. The Ovako Working Posture Assessment System (OWAS) was employed to assess working postures, while a weighing scale and measuring tape were used to record participants' weight and height. Multiple Linear Regression was performed to examine the relationship between the prevalence of WMSDs

and the identified risk factors. The results revealed that four factors—work duration, work tools, drinking habits, and smoking habits—were significantly associated with the prevalence of WMSDs. These findings highlight the importance of addressing these significant risk factors to improve the quality of life of street sweepers.

Keywords
Work-related Musculoskeletal Disorders, Street Sweepers, Risk Factors, MSD Severity and Frequency Questionnaire, Multiple Linear Regression

1. Introduction
Street sweepers play a crucial role in maintaining urban cleanliness, yet their physically demanding work exposes them to significant occupational health risks. Often perceived as undignified labor, street sweeping involves prolonged exposure to strenuous activities, poor working conditions, and limited ergonomic support. In the Philippines, street sweepers earn between PHP 230 to PHP 340 daily (Lagura & Ligan 2018), yet their labor-intensive tasks require extensive physical exertion. They rely on long-handled brooms and repetitive motions, which increase their vulnerability to work-related musculoskeletal disorders (WMSDs) (Gebremedhn & Raman 2020).

WMSDs affect bones, joints, muscles, and connective tissues, potentially leading to long-term disabilities (Selected Health Conditions and Likelihood of Improvement with Treatment 2020). A study from the Global Burden of Disease (GBD) 2019 estimates that 1.71 billion individuals worldwide suffer from musculoskeletal disorders, with 369 million cases recorded in Southeast Asia. Furthermore, work-related factors such as posture, duration, and environmental conditions exacerbate the prevalence of these disorders (Da Costa & Vieira 2009). Despite global evidence on the risks of WMSDs among street sweepers (Mishra et al. 2020; Abbaspour & Habibi 2020), limited research has been conducted in the Philippine context.Given the rising concerns over occupational health, this study aims to identify and analyze the risk factors associated with WMSDs among street sweepers in Quezon City. Understanding these risks is essential for developing ergonomic interventions and policies that promote workplace safety, ensuring that street sweepers can continue their work without compromising their health and well-being.

1.1 Objectives
This study aims to determine the risk factors contributing to WMSDs among street sweepers in Quezon City. By addressing these objectives, the study contributes to the growing body of occupational health research and provides actionable insights for improving working conditions for street sweepers in the Philippines. Specifically, it seeks to:

1. Identify the most frequently affected body parts exhibiting WMSDs among street sweepers.
2. Investigate the specific demographic, individual, occupational, and environmental risk factors associated with the development of WMSDs.
3. Analyze the implications of the study's findings for potential industry support and improvements.
4. Provide recommendations for future research on WMSDs in similar occupational settings.

2. Literature Review
The Prevalence of Musculoskeletal Disorders (MSDs) among Street Sweepers

The study by Alie et al. (2023) aimed to determine the burden and potential factors associated with musculoskeletal disorders (MSDs) among street cleaners in Gondar, Ethiopia. They found that 73% of respondents reported MSDs in the past 12 months. Factors such as age over 35 years, obese BMI, job dissatisfaction, and cleaning distance of 2 km or more per day were significantly associated with MSDs among street cleaners. However, their study had gaps, including a lack of consideration for posture and environmental factors associated with MSDs, no attribution of street sweeping as the cause of MSDs, failure to address seasonal variations, and limited observations due to categorical variables. The researchers addressed these gaps by exploring additional factors related to MSDs while continuing to adapt to studying variables such as age, BMI, and job satisfaction.

In a study by Oe & Ua (2020), the aim was to assess the occupational hazards and health problems of street sweepers in Uyo, Nigeria. They found that 63.3% of respondents experienced symptoms of musculoskeletal disorders (MSDs), with increasing age, sweeping distance, and work duration significantly associated with musculoskeletal pain prevalence. The researchers addressed similar gaps, including a lack of consideration for individual-related, ergonomic, and environmental factors associated with MSDs, no attribution of street sweeping as the cause of MSDs,

and limited observations due to categorical variables. The researchers further investigated work duration as a significant factor.

Mishra et al. (2020) aimed to establish an association between sociodemographic variables and various morbidities among street sweepers in South Mumbai, India. They found that musculoskeletal disorders (MSDs) were the second most common morbidity, affecting 88% of the street sweepers, particularly those aged over 40 years, males, literate individuals, middle-class socioeconomic status, and with occupational seniority over 5 years. However, their study had limitations, such as a small sample size and a lack of exploration of individual-related, ergonomic, and environmental factors associated with MSDs among street sweepers. The researchers further examined the significant variables such as age, gender, and occupational seniority.

Similarly, Park et al. (2020) aimed to determine the factors that affect occupational health injuries among street cleaners in South Korea, focusing on job characteristics and working environments. They found that participants with less experience, longer working hours, and heavy workloads had a higher risk of injury. However, their study had gaps, including a lack of consideration for individual-related, ergonomic, and external environmental factors associated with injuries among street cleaners, as well as limited observations due to categorical variables.

The Prevalence of Musculoskeletal Disorders (MSDs) among Other Industries in the Philippines

A study aimed to investigate the prevalence of musculoskeletal disorders (MSDs) among traffic enforcers in Manila City, Philippines, identified significant associations between MSD symptoms and factors like postural risk, heat exposure, noise exposure, and pollution exposure. This study focused on environmental and postural risk factors using binary logistic regression analysis. The study has utilized the Nordic Musculoskeletal Questionnaire (NMQ), Rapid Entire Body Assessment (REBA), and various environmental measuring devices, such as noise dosimeters and IAQ sensors. However, the study suggests a gap in exploring additional risk factors, such as work duration and area of assignment, which could enhance the understanding of MSD prevalence among traffic enforcers. Given the similarities in occupational demands between traffic enforcers and street sweepers, findings from this study informed the researchers by providing insights into potential shared risk factors affecting street sweepers' health and well-being (Gumasing et al. 2023).

Conclusion and Research Gap

The studies by Alie et al. (2023), Oe & Ua (2020), Mishra et al. (2020), and Park et al. (2020) collectively highlighted the prevalence of musculoskeletal disorders (MSDs). The researchers incorporated variables from their studies that demonstrated a significant association with musculoskeletal disorders (MSDs). However, several research gaps were identified across these studies. First, many of them overlooked important factors such as posture, individual-related factors, ergonomic factors, and environmental factors that may contribute to MSDs among street sweepers. The researchers adapted studying the significant variables from studies by Amit et al. (2020) and Gumasing et al. (2023). These included drinking habits, smoking habits, heat exposure, and noise exposure. Second, none of the studies attribute street sweeping as the direct cause of MSDs. Third, most of the studies primarily relied on categorical variables for data collection, which may have limited the depth of the findings. Additionally, some studies rely solely on questionnaire-based measurements, which may not have accurately captured certain variables like posture. These gaps highlighted the need for further research that considers a wide range of factors and for employing more rigorous methodologies to address the complexities of MSDs among street cleaners.

3. Methods

The study, aiming to determine the risk factors affecting the prevalence of WMSDs, involved gathering data on age, gender, BMI, work posture, heat and noise exposure, smoking and drinking habits, work duration, and work tools. In analyzing the data, the researchers utilized multiple linear regression as the statistical tool which provided relevant insights into the significant risk factors affecting WMSDs among street sweepers.

3.1 Research Design

The study applied a quantitative method using a non-experimental approach to examine the risk factors affecting work-related musculoskeletal disorders (WMSDs) among street sweepers. Several studies that described the relationship between the independent variables (risk factors) and the dependent variable (WMSDs) served as the basis for the study. With this, a researcher-administered questionnaire and several assessment tools were conducted among street

sweepers. Upon collecting data, the researchers used multiple linear regression to assess the relationship between the dependent and independent variables and determine the risk factors associated with the prevalence of WMSDs.

3.2 Subjects and Study Site

Focusing on District 4 of Quezon City, the researchers gathered data from street sweepers in this area, as Quezon City is the largest city in Metro Manila in terms of land area and population. This was further narrowed down to the selection of street sweepers who met the specified qualifications for the study. The qualifications included (1) the street sweeper having been actively engaged in work for the past 3 months and (2) the street sweeper having reported WMSD. With the assistance of the Barangay and Community Relations Department (BCRD), the number of street sweepers employed in each barangay of Quezon City was known, making it easier to locate them.

3.3 Sampling Plan and Sample Size

The researchers utilized G*Power software to determine the appropriate sample size for the study. In the analysis, 11 predictors or independent variables, composed of 10 observed variables and one latent variable, were involved. An alpha level of 0.05 and an effect size of 0.15 were set as the parameters for the computation. Based on these parameters, the computed sample size was 123, ensuring sufficient power to detect medium effects in the data. as a 95% confidence level was maintained, and the risk of Type I errors was reduced to 5%.

4. Data Collection

Data was collected through surveys and face-to-face interviews with street sweepers in Quezon City to assess demographic, individual, work-related, and environmental factors contributing to work-related musculoskeletal disorders (WMSD). Ethical considerations, including informed consent, confidentiality, and compliance with the Data Privacy Act (RA 10173), were strictly observed. The survey questionnaire focused on the challenges and effects that work-related conditions have on musculoskeletal health. The MSD Severity and Frequency Questionnaire evaluated musculoskeletal discomfort, while the Ovako Working Posture Analysis System (OWAS) assessed ergonomic risks.

4.1 Data Measures

Key independent variables affecting WMSDs among street sweepers were categorized into demographic factors (age, gender, occupational seniority), individual-related factors (BMI, smoking habits, drinking habits), work-related factors (work duration, work posture, work tools), and environmental factors (heat and noise exposure). Each variable was measured using appropriate tools and methods, such as BMI calculations through weight and height measurements using a weighing scale and measuring tape, work posture assessment using OWAS, and environmental conditions recorded via a heat stress meter and sound level meter.

4.2 Data Gathering Procedure

The researchers began the data collection process with screener questions to determine if they had experienced work-related musculoskeletal disorders (WMSDs). If eligible, the MSD Severity and Frequency (MSF) Questionnaire was administered to assess the extent and impact of their musculoskeletal discomfort. Researchers then took photos of the street sweepers' sweeping positions, which were later analyzed using the Ovako Working Posture Assessment System (OWAS) to evaluate ergonomic risks. Additionally, environmental factors such as heat and noise exposure were measured using a heat stress meter and sound level meter while weighing scales and measuring tapes recorded the participants' physical attributes. The collected data underwent multiple linear regression analyses to identify key risk factors for WMSDs, forming the foundation for the study's conclusion and recommendations.

5. Results and Discussion

5.1 Numerical Results

The following numerical results show the use of Multiple Linear Regression, a statistical technique used to assess the significant relationship between the dependent variable (prevalence of MSDs) and independent variables (age, gender, BMI, occupation seniority, drinking habit, smoking habit, work duration, work posture, heat exposure, noise exposure, and job satisfaction) simultaneously. Prior to conducting the multiple linear regression, the researchers examined six assumptions to ensure the quality of data and its validity for the use of the statistical tool. Each assumption was carefully checked using various tests in the IBM SPSS Statistics.

Table 1. Regression Model Summary with Durbin-Watson Test

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.921[a]	.849	.836	7.61843	.849	66.919	10	119	<.001	1.827

a. Predictors: (Constant), NoiseExposure, WorkDuration, Age, BMI, Gender, WorkPosture, HeatExposure, DrinkingHabits, SmokingHabits, WorkTool

b. Dependent Variable: WMSD

Table 1 shows that the Durbin-Watson statistic relays a value of 1.827 which is considered to be free of any autocorrelation satisfying the independence assumption.

Table 2. Variance Inflation Factor (VIF) Test Results

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-8.874	20.435		-.434	.665	-49.337	31.589		
	Age	-.076	.064	-.044	-1.181	.240	-.204	.051	.924	1.083
	Gender	-.407	1.726	-.009	-.236	.814	-3.824	3.010	.887	1.127
	BMI	-.025	.841	-.001	-.030	.976	-1.691	1.641	.920	1.087
	DrinkingHabits	2.787	.963	.145	2.893	.005	.880	4.694	.503	1.989
	SmokingHabits	2.163	.920	.136	2.351	.020	.341	3.984	.381	2.627
	WorkDuration	6.643	.848	.467	7.835	<.001	4.965	8.322	.356	2.805
	WorkPosture	.133	.114	.044	1.164	.247	-.093	.360	.883	1.132
	WorkTool	8.069	1.598	.296	5.048	<.001	4.904	11.234	.368	2.717
	HeatExposure	-.449	.551	-.035	-.814	.417	-1.541	.643	.668	1.498
	NoiseExposure	.067	.229	.012	.293	.770	-.387	.521	.780	1.282

a. Dependent Variable: WMSD

Table 2 indicated that all predictors had values below 5, indicating no significant multicollinearity among the independent variables. This implies that the predictors are not highly correlated and independently contributed to the regression model.

Table 3. Added Mahalanobis Distances and Associated Probabilities

WMSD	Age	Gender	OccupationalSeniority	BMI	DrinkingHabits	SmokingHabi.	WorkDuration	WorkPosture	WorkTool	HeatExposure	NoiseExposure	MAH_1	Probability_MD	Outlier
48.00	33.00	1	11.00	3	1	1	8.00	26.00	3.00	29.10	82.10	29.14068	.00118	.00
21.00	36.00	2	1.00	4	3	1	3.00	40.00	2.00	29.30	83.10	23.17163	.01013	.00
91.00	42.00	2	22.00	5	3	2	8.00	21.00	4.00	27.60	84.80	21.52678	.01771	.00
84.00	59.00	1	20.00	2	3	3	8.00	37.00	4.00	27.00	75.60	20.95380	.02142	.00
19.00	65.00	1	1.00	5	0	0	3.00	51.00	2.00	29.90	81.00	20.91187	.02172	.00
69.00	23.00	2	6.00	3	0	3	5.00	31.00	4.00	26.50	80.00	20.23849	.02708	.00
40.00	50.00	1	8.00	2	1	3	4.00	21.00	3.00	27.00	80.70	18.35229	.04930	.00
24.00	65.00	1	1.00	4	2	0	3.00	33.00	3.00	27.30	73.00	18.23205	.05117	.00
73.00	58.00	2	19.00	2	0	3	7.00	34.00	4.00	27.40	81.60	17.98043	.05529	.00
47.00	57.00	1	10.00	3	3	0	4.00	33.00	3.00	27.50	75.80	17.71701	.05993	.00
12.00	42.00	1	.50	4	1	0	2.00	20.00	2.00	27.90	86.10	17.45604	.06486	.00
99.00	60.00	2	21.00	5	2	3	8.00	30.00	5.00	27.40	78.60	17.06484	.07294	.00
24.00	44.00	2	1.00	1	0	0	3.00	38.00	3.00	29.70	86.20	16.66223	.08218	.00
38.00	47.00	1	7.00	2	0	0	4.00	51.00	3.00	29.90	79.70	16.50743	.08600	.00
8.00	68.00	1	.25	3	0	0	2.00	41.00	1.00	29.30	82.70	16.27785	.09195	.00
61.00	54.00	2	15.00	3	2	3	3.00	34.00	4.00	28.60	81.90	16.19476	.09419	.00
38.00	60.00	2	7.00	3	0	0	4.00	28.00	3.00	34.30	85.30	16.08253	.09729	.00
15.00	57.00	1	.58	4	0	0	2.00	25.00	2.00	32.60	84.00	15.84271	.10422	.00
37.00	49.00	2	6.00	5	2	0	4.00	30.00	3.00	26.80	73.00	15.19518	.12511	.00
8.00	62.00	2	.33	3	0	0	2.00	40.00	1.00	29.90	78.80	15.12596	.12754	.00
31.00	65.00	2	4.00	3	0	3	4.00	35.00	3.00	27.00	78.40	14.98666	.13255	.00
45.00	39.00	1	10.00	3	1	3	4.00	34.00	3.00	26.30	82.20	14.76654	.14081	.00
63.00	50.00	2	17.00	3	3	3	4.00	31.00	4.00	26.80	76.30	14.75769	.14115	.00
78.00	46.00	2	20.00	3	3	3	8.00	29.00	4.00	26.80	81.40	14.67147	.14451	.00
6.00	53.00	2	.25	3	0	0	2.00	27.00	1.00	27.80	80.80	14.49691	.15151	.00
18.00	30.00	2	.83	5	1	0	2.00	23.00	2.00	30.30	79.90	14.20516	.16384	.00
13.00	59.00	2	11.00	3	0	2	2.00	43.00	2.00	28.90	84.10	14.03511	.17140	.00
37.00	58.00	1	17.00	3	3	3	5.00	33.00	4.00	29.70	86.90	13.94582	.17548	.00
12.00	60.00	1	.50	3	1	0	2.00	40.00	2.00	32.60	83.60	13.90775	.17724	.00
30.00	61.00	2	4.00	4	0	3	4.00	35.00	3.00	29.30	82.20	13.75069	.18467	.00
34.00	23.00	1	5.00	3	0	0	4.00	24.00	3.00	29.90	79.50	13.69396	.18741	.00
51.00	71.00	2	20.00	4	2	3	7.00	38.00	4.00	29.70	84.90	13.43003	.20061	.00
20.00	45.00	1	1.00	4	0	0	3.00	39.00	2.00	27.90	75.10	13.36928	.20375	.00
28.00	53.00	2	3.00	4	0	2	4.00	23.00	3.00	29.90	77.30	13.31751	.20646	.00
16.00	26.00	2	.67	3	0	0	2.00	37.00	2.00	27.90	83.70	13.28067	.20840	.00
18.00	62.00	2	.83	4	0	1	4.00	37.00	2.00	31.60	83.90	12.14354	.27556	.00
42.00	57.00	2	4.00	5	0	0	4.00	45.00	3.00	29.90	78.10	12.06671	.28062	.00
42.00	54.00	2	8.00	2	1	0	4.00	22.00	3.00	26.40	78.00	11.85727	.29472	.00
27.00	59.00	2	2.00	5	0	0	4.00	23.00	3.00	28.90	85.30	11.71045	.30490	.00
51.00	37.00	2	11.00	2	1	1	5.00	38.00	3.00	26.70	79.50	11.69022	.30632	.00

In Table 3, all p−values associated with the Mahalanobis Distance were above the critical threshold ($p \geq 0.001$), indicating no statistically significant outliers. A visual inspection of residual plots further supported this conclusion, showing no extreme or overly influential points that could distort the regression model.

Table 4. Model Summary and Fit

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.921[a]	.849	.836	7.61843	.849	66.919	10	119	<.001

a. Predictors: (Constant), NoiseExposure, WorkDuration, Age, BMI, Gender, WorkPosture, HeatExposure, DrinkingHabits, SmokingHabits, WorkTool

b. Dependent Variable: WMSD

In Table 4, the model explained that 84.9% or approximately 85% of the variance in MSD prevalence can be attributed to the independent variables included in the model ($R2 = 0.849$, $F(10, 119) = 66.919$, $p < 0.001$). Based on Field (2024), the R2 value of 0.849 implies a strong fit of the model and suggests that the identified factors are significant predictors of WMSDs.

Table 5. Pearson Correlation Matrix for WMSD and Predictor Variables

Correlations

		WMSD	Age	Gender	BMI	DrinkingHabits	SmokingHabits	WorkDuration	WorkPosture	WorkTool	HeatExposure	NoiseExposure
WMSD	Pearson Correlation	1	.003	-.022	-.024	.652**	.724**	.865**	-.052	.815**	-.339**	.016
	Sig. (2-tailed)		.975	.807	.790	<.001	<.001	<.001	.556	<.001	<.001	.856
	N	130	130	130	130	130	130	130	130	130	130	130
Age	Pearson Correlation	.003	1	-.037	-.055	.081	.071	.004	.245**	.044	.007	-.047
	Sig. (2-tailed)	.975		.680	.533	.361	.422	.966	.005	.620	.939	.599
	N	130	130	130	130	130	130	130	130	130	130	130
Gender	Pearson Correlation	-.022	-.037	1	.169	-.135	-.014	-.014	-.143	.074	.011	-.081
	Sig. (2-tailed)	.807	.680		.055	.126	.873	.871	.104	.406	.901	.358
	N	130	130	130	130	130	130	130	130	130	130	130
BMI	Pearson Correlation	-.024	-.055	.169	1	.040	-.064	-.002	-.106	-.040	.107	.070
	Sig. (2-tailed)	.790	.533	.055		.651	.466	.983	.228	.651	.226	.428
	N	130	130	130	130	130	130	130	130	130	130	130
DrinkingHabits	Pearson Correlation	.652**	.081	-.135	.040	1	.646**	.551**	-.036	.514**	-.368**	.019
	Sig. (2-tailed)	<.001	.361	.126	.651		<.001	<.001	.686	<.001	<.001	.829
	N	130	130	130	130	130	130	130	130	130	130	130
SmokingHabits	Pearson Correlation	.724**	.071	-.014	-.064	.646**	1	.636**	.004	.621**	-.395**	.129
	Sig. (2-tailed)	<.001	.422	.873	.466	<.001		<.001	.968	<.001	<.001	.144
	N	130	130	130	130	130	130	130	130	130	130	130
WorkDuration	Pearson Correlation	.865**	.004	-.014	-.002	.551**	.636**	1	-.113	.764**	-.272**	.010
	Sig. (2-tailed)	<.001	.966	.871	.983	<.001	<.001		.199	<.001	.002	.914
	N	130	130	130	130	130	130	130	130	130	130	130
WorkPosture	Pearson Correlation	-.052	.245**	-.143	-.106	-.036	.004	-.113	1	-.087	.083	-.025
	Sig. (2-tailed)	.556	.005	.104	.228	.686	.968	.199		.323	.345	.777
	N	130	130	130	130	130	130	130	130	130	130	130
WorkTool	Pearson Correlation	.815**	.044	.074	-.040	.514**	.621**	.764**	-.087	1	-.259**	-.036
	Sig. (2-tailed)	<.001	.620	.406	.651	<.001	<.001	<.001	.323		.003	.686
	N	130	130	130	130	130	130	130	130	130	130	130
HeatExposure	Pearson Correlation	-.339**	.007	.011	.107	-.368**	-.395**	-.272**	.083	-.259**	1	.323**
	Sig. (2-tailed)	<.001	.939	.901	.226	<.001	<.001	.002	.345	.003		<.001
	N	130	130	130	130	130	130	130	130	130	130	130
NoiseExposure	Pearson Correlation	.016	-.047	-.081	.070	.019	.129	.010	-.025	-.036	.323**	1
	Sig. (2-tailed)	.856	.599	.358	.428	.829	.144	.914	.777	.686	<.001	
	N	130	130	130	130	130	130	130	130	130	130	130

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 shows the positive or negative associations of the specific variables to the WMSDs of street sweepers based on the Pearson correlation found by the software.

5.2 Graphical Results

In addition to the numerical results presented in Section 5.1, the following graphical results further show the adherence of the collected data to the assumptions of multiple linear regression (MLR):

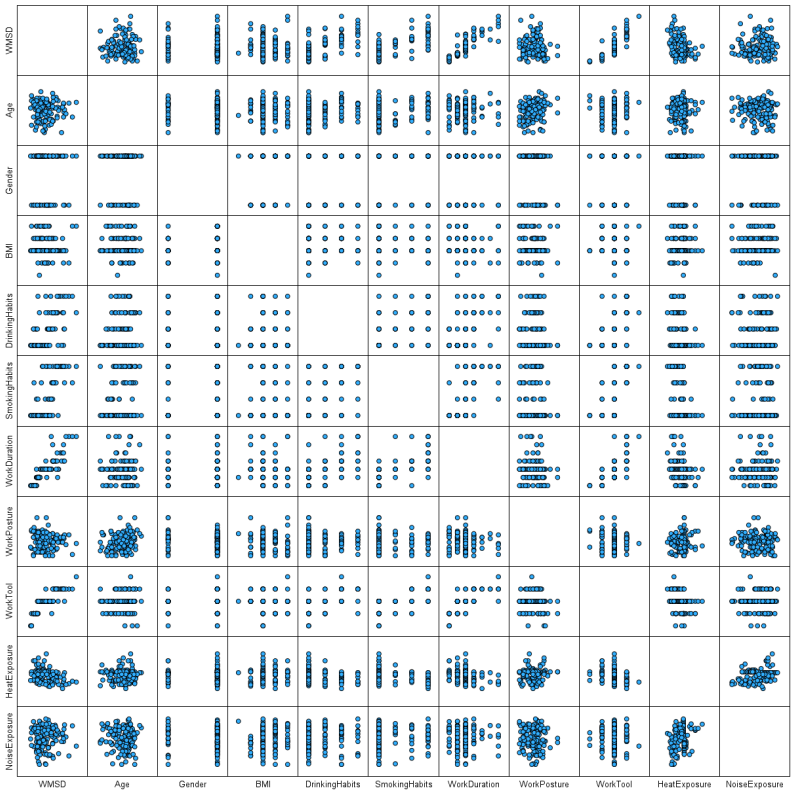

Figure 1. Scatter Plot Matrix of WMSD and Predictor Variables

Figure 1 shows the test for linearity, wherein BMI, drinking and smoking habits, work duration, and work tools are observed to have a linear relationship with WMSD as the scatter plots form a line. Contrary to this, age, gender, work posture, and exposure to heat and noise do not follow a consistent pattern, indicating that these factors do not have a linear relationship with WMSD.

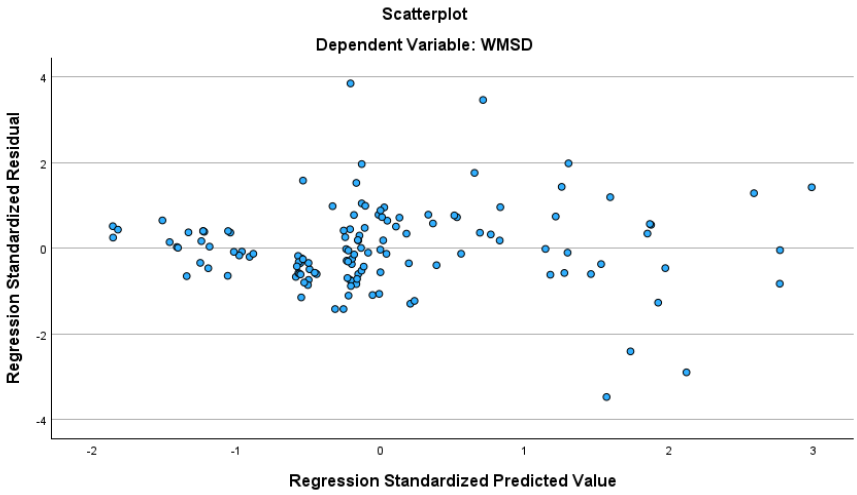

Figure 2. Homoscedasticity Residual Plot

Figure 2 assesses the homoscedasticity of the data, showing that the residuals are relatively evenly scattered across all levels of predicted values without any clear patterns observed. This indicates that the data satisfied the assumption of homoscedasticity and that its residuals are constant.

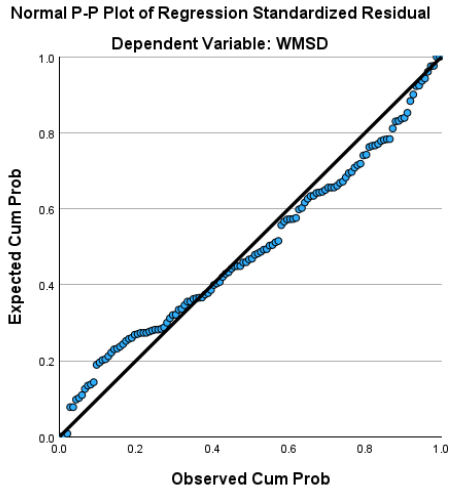

Figure 3. Normal P-P Plot of Standardized Residuals

Figure 3 shows the test for normality using a normal P-P plot. The results confirm normality, as the standardized residuals closely follow a diagonal line.

5.3 Proposed Improvements

As the study primarily found that work duration had the strongest correlation with the presence of WMSDs in street sweepers, the researchers propose implementing work rotations to mitigate the prolonged strain experienced by individual street sweepers. Increasing the number of workers to enable rotations would effectively reduce their extended exposure to strenuous tasks. This aligns with the findings of Oe and Ue (2020), who also recommended increasing the number of sweepers assigned to specific roads to distribute the workload more evenly and alleviate the physical demands on each individual. Regular, shorter breaks should also be imposed to allow for ample recovery time and prevent overall fatigue.

The study also found a strong correlation between improper work tools and the presence of WMSDs, indicating that ergonomic interventions are severely needed to limit the risk for street sweepers. The researchers recommend that local barangay offices provide street sweepers with lightweight, adjustable brooms and dustpans and, if feasible, equip them with waste carts to reduce repetitive strain during waste collection. This recommendation aligns with the findings of Abbaspour and Habibi (2020), who emphasized the importance of designing ergonomic tools tailored to workers' posture and body movements. It is also recommended that the sweeper's tools be regularly assessed for their effectiveness and ergonomic quality due to the highly physical nature of street sweeping tools that may be prone to breaking thus making them ineffective.

The researchers recommend implementing an initial health screening for street sweepers prior to employment to identify any negative habits, such as smoking and drinking, as well as pre-existing ailments that could impact their suitability for the role. This screening would also help identify sweepers at risk of work-related musculoskeletal disorders (WMSDs), allowing for better monitoring and early intervention. The study revealed a significant correlation between smoking and drinking habits and the prevalence of WMSDs, highlighting the need for proactive measures to promote healthier lifestyles among sweepers. To address this, the researchers suggest that local government units organize health awareness programs, including workshops and seminars, to educate sweepers on the risks of smoking and alcohol consumption and their contribution to physical strain. This recommendation aligns with Amit et al. (2020), who emphasized the importance of strengthening policies and regulations to promote a healthier work environment.

5.4 Validation

Table 6 shows the regression analysis results and the regression coefficients that indicate the direction and magnitude of the relationship between each independent variable and WMSD. The significance values (p-values) help determine which predictors are statistically significant in explaining variations in WMSD (Statistics Solutions, 2017).

Table 6. Regression Coefficients for the Predictors of WMSD

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-8.874	20.435		-.434	.665	-49.337	31.589		
	Age	-.076	.064	-.044	-1.181	.240	-.204	.051	.924	1.083
	Gender	-.407	1.726	-.009	-.236	.814	-3.824	3.010	.887	1.127
	BMI	-.025	.841	-.001	-.030	.976	-1.691	1.641	.920	1.087
	DrinkingHabits	2.787	.963	.145	2.893	.005	.880	4.694	.503	1.989
	SmokingHabits	2.163	.920	.136	2.351	.020	.341	3.984	.381	2.627
	WorkDuration	6.643	.848	.467	7.835	<.001	4.965	8.322	.356	2.805
	WorkPosture	.133	.114	.044	1.164	.247	-.093	.360	.883	1.132
	WorkTool	8.069	1.598	.296	5.048	<.001	4.904	11.234	.368	2.717
	HeatExposure	-.449	.551	-.035	-.814	.417	-1.541	.643	.668	1.498
	NoiseExposure	.067	.229	.012	.293	.770	-.387	.521	.780	1.282

a. Dependent Variable: WMSD

Table 7. Results and Description of Hypothesis

Hypothesis Statement	P-Value	Result	Description
H1: There is a significant association between age and work-related musculoskeletal disorders among street sweepers.	0.240	Insignificant	H1 Rejected
H2: There is a significant association between gender and work-related musculoskeletal disorders among street sweepers.	0.814	Insignificant	H2 Rejected
H3: There is a significant association between occupational seniority and work-related musculoskeletal disorders among street sweepers.	-	-	-
H4: There is a significant association between BMI and work-related musculoskeletal disorders among street sweepers.	0.976	Insignificant	H4 Rejected
H5: There is a significant association between drinking habits and work-related musculoskeletal disorders among street sweepers.	0.005	Significant	H5 Accepted
H6: There is a significant association between smoking habits and work-related musculoskeletal disorders among street sweepers.	0.020	Significant	H6 Accepted
H7: There is a significant association between work duration and work-related musculoskeletal disorders among street sweepers.	<0.001	Significant	H7 Accepted
H8: There is a significant association between work posture and work-related musculoskeletal disorders among street sweepers.	0.247	Insignificant	H8 Rejected
H9: There is a significant association between work tools and work-related musculoskeletal disorders among street sweepers.	<0.001	Significant	H9 Accepted
H10: There is a significant association between heat exposure and work-related musculoskeletal disorders among street sweepers.	0.417	Insignificant	H10 Rejected
H11: There is a significant association between noise exposure and work-related musculoskeletal disorders among street sweepers.	0.770	Insignificant	H11 Rejected

Table 7 summarizes the hypothesis testing results on factors influencing WMSDs among street sweepers. Drinking habits, smoking habits, work duration, and work tools showed significant associations, while age, gender, BMI, work posture, heat exposure, and noise exposure were not statistically significant.

6. Conclusion

This study successfully identified the risk factors affecting work-related musculoskeletal disorders (WMSDs) among street sweepers in Quezon City, fulfilling its primary objective. By analyzing various demographic, individual-related, work-related, and environmental factors, the research determined that work duration, work tools, drinking habits, and smoking significantly contribute to the prevalence of WMSDs. The findings highlighted that increased alcohol consumption, smoking frequency, prolonged work duration, and dissatisfaction with work tools lead to higher levels of musculoskeletal discomfort. Conversely, factors such as age, gender, BMI, work posture, heat exposure, and noise exposure showed no significant relationship with WMSDs, suggesting that their variations do not directly impact the condition.

A key contribution of this study is its empirical evidence on an overlooked labor sector, reinforcing the urgent need for ergonomic interventions and policy improvements tailored to street sweepers' working conditions. The cost-benefit analysis further demonstrated that with minimal financial investment and behavioral changes, the health and well-being of street sweepers can significantly improve. These insights provide a strong foundation for future research and policymaking aimed at reducing occupational health risks and enhancing the overall quality of life for workers in physically demanding environments.

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