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Postural Analysis and Musculoskeletal Symptoms in Vehicle Drivers of an Automotive's Logistics Service Provider (3PL)

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Abstract. The cases of Occupational Diseases in the Workplace survey conducted by the Philippine Statistics Authority (PSA) last 2015 showed a 17% growth in the Transportation and Storage industry cases despite the decrease in total cases for that year. It can be related to the increasing demand for this sector, specifically the use of services from a third-party logistics company or 3PL. A 3PL is a firm that uses its resources and assets to provide value-adding logistics and transportation services to a company. One of the industries in the Philippines that engaged with this firm is the automotive sector. The automotive sector in the Philippines is a thriving industry despite facing many challenges since the accelerated growth last 2015, which was deemed as the "motorization" for the country. This year, the industry is still optimistic about reaching 273,000 vehicles sold. In this regard, the study aims to determine the present ergonomic condition of vehicle drivers working in a 3PL that provides services to an automotive company. A survey using Cornell Musculoskeletal Discomfort Questionnaires (CMDQ) and onsite Rapid Entire Body Assessment (REBA) was used to determine the possible occurrence of Musculoskeletal disorder (MSD) and postural risks, respectively amongst 20 vehicle drivers. Subsequently, the REBA score was evaluated, and the survey results were statistically analyzed, identifying the prevailing MSD symptoms. Likewise, the latter were correlated with the drivers' age and working experience, showing possible relation of experiencing MSD to these two factors. Finally, the result of the study was compared to another related study to demonstrate the similarity of ergonomic risks to that of drivers in transportation and other logistics sectors.

Keywords: musculoskeletal disorder (MSD), REBA, physical ergonomics, vehicle drivers of the automotive industry, third party logistics

1. Introduction

1.1. Automotive Industry in the Philippines

The automotive industry in the Philippines covers the importation, assembly, rebuilding of motor vehicles, production of auto parts and components, and distribution of vehicles to final customers [1]. Currently, the market is dominated significantly by Japanese automakers with a 77.7% market share. Toyota Motor Philippines Corporation is the leading automaker, followed by Mitsubishi Motor Philippines Corporation and Isuzu Philippine Corporation [2].

The year 2015 for the Philippines' automotive industry is the year of "motorization", a phenomenon that prompts the rapid acceleration of demand for vehicles [3]. The industry experienced accelerated growth of 23% on average from 2012 to 2015. Based on the data published by the Chamber of Automotive Manufacturers, Inc. (CAMPI) and the Truck Manufacturers Association (TMA), the recorded sales were 288,609 vehicles. With this trend, the automotive industry was projected to continuously grow as the Philippines is close enough to meet $3,000 per capital incoming, as indicated by the motorization phase [2].

However, the auto industry's sales are continuously challenged with the imposition of government taxes on vehicles in 2018 and 2019 and the ongoing COVID-19 pandemic recently. Last year the industry only

recorded 248, 171 sold vehicles. While this is the case, the sector is still optimistic about reaching 273,000 vehicles sold by the end of 2021 [3].

The automakers are continuously working side-by-side with local firms such as local auto-parts manufacturers as well as logistics service providers to fulfill the demand in vehicles [1].

1.2. Third-party Logistics (3PL)

A third-party logistics provider (3PL) are organizations that use its resources and assets to act on behalf of its customer to manage and execute value-adding logistics services and transportation functions. The organization offers various services such as carrier selection, route scheduling, shipment storage, parts assembly, and transportation. Getting the service of a 3PL allows the company to focus on its core function and reduce costs and capital expenses [4].

In the automotive industry, a 3PL is a company that offers logistics solutions for the industry's existing challenges due to the increasing demand for product variety, improved quality, changing marketplace, and globalization. These companies provide logistics solutions and help the manufacturers make strategic decisions to ensure an efficient connection between the plant, suppliers, and end customers. To better understand the role of the 3PL in the industry, there are five types of logistics systems based on the function: (1) Procurement logistics (flow of direct and indirect raw materials), (2) Production logistics (flow of materials inside the factory), (3) Sales Logistics (delivery of products from warehouses to wholesalers, retailers and directly to the customers), (4) Recovery Logistics (flow of returns from customers), (5) Recycling logistics (recovers and recycle) [4].

1.3. Occupational Diseases in Logistics Services Sector

Based on the survey conducted by the Philippine Statistics Authority (PSA) on occupational Diseases in the Workplace in 2015, the recorded total case was 125,973. It is relatively lower than 2013 (171,787) cases by 26.7%. From 18 industries, 13 industries reported a decline in the mining and quarrying sectors, with the highest recorded decrease of 81.3% from 2013. On another note, 5 industries recorded an increase, with real estate activities growing the most cases by 189.6%. Another growth is seen in the transportation and storage sector (where logistics services are part of the sector), with a significant increase of 17.0%. For all the industries, Back pain is still the most common type of occupational disease among workers, while work-related musculoskeletal diseases escalated the most during this period [5].

1.4. Focus of the Study

The study aims to discover the current physical ergonomic condition of vehicle drivers employed in a third-party logistics (3PL) given the current recovery in vehicle sales of the automotive industry.

The study assesses the drivers' posture and identifies possible risks associated with the job using physical ergonomic tools. Likewise, the study identifies the occurrence of musculoskeletal disease (MSD) among the drivers, its frequency of occurrence, work interference, and possible relation of developing MSD to the length of employment as drivers and driver’s age.

2. Methodology

2.1. Scope

The study was conducted in a third-party logistics company (3PL). The 3PL is under contract with one of the leading automotive companies in the Philippines. The contract requires the 3PL to perform vehicle inventory management and vehicle handling operation. Vehicle handling operation is divided into two sub-operation: (1) Incoming (inbound) vehicle handling operation for imported vehicles coming into the stockyard (2) Outgoing (outbound) vehicle handling operation for sold vehicles to deliver to car dealers using car carrier trucks. The outgoing vehicle handling operation consists of the following tasks performed by vehicles by drivers: (1) Vehicle inspection (walking around the vehicle) and (2) Vehicle driving or shifting from the stockyard to pre-loading area to be readied for loading to the car carrier. Currently, the working hour for these processes is 8 hours per shift, a three-shift operation. The identified subject of this

study was the vehicle drivers assigned to these processes and those in mid-shift operation (2:00 pm to 10:00 pm working time).

2.2. Data Collection

1) Ergonomic assessment tool

The assessment tool that was used for this study is the combination of REBA (Rapid Entire Body Assessment) and the Cornell Musculoskeletal Discomfort Questionnaires (CMDQ). REBA tool is used to analyze the posture of the vehicle drivers as the tool provides a quick and systematic assessment of the entire body posture risks. Moreover, it estimates risks of having entire body disorders due to the current nature of the job [6]. While the CMDQ, a questionnaire developed by Dr. Alan Hedge and his ergonomics graduate students at Cornell University [7], [8], is used to identify the possible occurrence of MSD, its severity, and the possibility of work interference among the drivers.

2) Procedure

The following steps was performed to collect the data:

- Step 1: Discussion and detailed explanation of the study (including tools) to be conducted among the vehicle drivers.
- Step 2: Posture analysis using REBA based on onsite observation of the two tasks identified: (1) vehicle inspection and (2) vehicle driving
- Step 3: Identify the number of participants for the survey
- Step 4: Perform a survey on drivers, which includes age, gender, number of years working as a driver, and CMDQ questionnaire.

2.3. Summary and Analysis

The scores generated on the tasks observed using REBA were analyzed according to the posture risk level. While the CMDQ questionnaire results were subjected to descriptive analysis to identify the body region with prevailing MSD, its severity, and work interference. Likewise, to estimate the possible relationship of experiencing MSD versus driver's age and the number of years working as drivers.

3. Results and Discussion

3.1. Participants

The study was participated by 20 male vehicle drivers assigned to inspect and drive to the car carrier truck pre-loading area. Table 1 and Table 2 show the overall profile in terms of age and working experience of the subject drivers.

Table 1: Age Group of Vehicle Drivers

Age Group (in years)	No. of Drivers (%)
26-30	6 (30%)
31-35	2 (10%)
36-40	8 (40%)
41-45	3 (15%)
46-50	I (5%)

Table 2: Total Years Working as a Vehicle Driver

Working Experience (in years)	No. of Drivers (%)
2-5	9 (45%)
6-9	3 (15%)

10-13	3 (15)
14-17	1 (5%)
18-21	4 (20%)

In summary, 50% of the surveyed drivers have an age between 30 to 40 years old while in terms of work experience, 40% have been working as drivers between 10 to 20 years.

3.2. Rapid Entire Body Assessment (REBA)

Based on actual observation, the REBA scores of both vehicle inspection process and vehicle driving or shifting process yield scores of 7.0 (see Annex A) and 4.0 (see Annex B), respectively. There is a medium risk of developing MSD over time if change cannot be implemented soon. Further, the mentioned processes are done in repetition as drivers need to inspect and drive the target number of vehicles for delivery, averaging between 450 to 500 vehicles daily.

3.3. Musculoskeletal Disorder (MSD) Symptoms

The information gathered using CMDQ was subjected to descriptive analysis. Table 3 shows that the drivers frequently experienced pain, ache, and discomfort on the upper and lower back (14.3%). Nevertheless, it is noteworthy that 45.8% is from the lower extremity part of the body. These are the foot, legs, knees, and thighs. Drivers experienced discomfort in these mentioned body regions mostly 1-2 times a week (80%), as shown in Table 4.

Table 3: Frequency of Msd Symptoms Per Body Region

Body Region	Total Frequency (n=drivers)	%
Back	48 (14)	14.3%
Foot	44 (14)	13.1%
Lower Leg	39 (13)	11.6%
Knee	37 (11)	11.0%
Thigh	34 (10)	10.1%
Shoulder	34 (9)	10.0%
Upper Arm	25 (6)	7.4%
Neck	24 (10)	7.0%
Hip/Buttocks	23 (10)	6.8%
Wrist	18 (5)	5.2%
Forearm	12 (4)	3.6%

In terms of severity, it is still the body parts of the lower extremity (43%) that causes the uncomfortable feeling to the drivers whenever they experience pain on these body parts. The back and shoulder follow this. Shown in Table 4 the details of the severity of the symptoms:

Table 4: Severity of Msd Symptoms Per Body Region

Body Region	Severity	%
Knee	58	11.6%
Lower Leg	56	11.2%
Foot	52	10.4%
Back	51	10.2%
Shoulder	50	10.0%
Thigh	48	9.6%
Upper Arm	45	9.0%

Wrist	44	8.8%
Forearm	42	8.4%
Hip/Buttocks	27	5.4%
Neck	25	5.0%

74% of the drivers (see Table 5) answered that the pain they experienced on these body parts is slightly uncomfortable except for the pain on the knees and lower leg. Notably, 45% (9 drivers) and 40% (8 drivers) answered that they felt moderately uncomfortable when they experienced pain on the knees and lower leg.

Table 5: Level of Uncomfortability

Body Region	**Slightly uncomfor-table (n=drivers)**	**Moderatel y uncom-fortable (n=drivers)**	**Very uncomfor-table (n=drivers)**
Knee	55% (11)	45% (9)	0%
Lower Leg	60% (12)	40% (8)	0%
Foot	70% (14)	30% (6)	0%
Back	75% (15)	25% (5)	0%
Shoulder	75% (15)	25% (5)	0%
Thigh	80% (16)	20% (4)	0%

Finally, Table 6 summarizes the possible interference of body pain on the work of the drivers. As shown below, the same results were captured wherein the drivers experienced pain in the lower extremity body parts, which resulted in working interference. Moreover, Table 7 indicates that 50% (10 drivers), 30% (6 drivers), and 30% (6 drivers) of the drivers answered that discomfort in knees, back, and lower leg respectively interfere slightly in their work, while 1 driver confirms substantially interfered work due to discomfort in the back region.

Table 6: Work Interference

Body Region	**Severity**	**%**
Knee	60	11.7%
Back	59	11.5%
Lower Leg	52	10.2%
Foot	52	10.2%
Thigh	51	10.0%
Upper Arm	49	9.6%
Shoulder	48	9.4%
Wrist	46	9.0%
Forearm	44	8.6%
Neck	26	5.1%
Hip/Buttocks	25	4.9%

Table 7: Work Interference

Body Region	**Not at all (n=driver s)**	**Slightly interfere d (n=driver**	**Substanti ally interfere d**

		s)	(n=drivers)
Knee	50% (10)	50% (10)	0%
Back	65% (13)	30% (6)	5% (1)
Lower Leg	70% (14)	30% (6)	0%
Foot	70% (14)	30% (6)	0%
Thigh	80% (16)	15% (3)	5% (1)
Upper Arm	75% (15)	25% (5)	0%

3.4. Age and Work experience relation with MSD Symptoms

To summarize the responses of each driver, the frequency, severity, and work interference data were multiplied. Then, the result was compared by age and work experience to check for a possible relationship between the said two factors. The results are summarized in Table 8 and Table 9.

Table 8: Age Vs. MSD Symptoms

Age (years)	**No. of Drivers**	**Overall CMDQ Result** ***(Freq x Severity x Work Interference)***		
		Average	**Min**	**Max**
26-30	6	21.9	0.0	42.5
31-35	2	39.8	21.0	58.5
36-40	8	53.2	0.0	174
41-45	3	54.0	18.0	93
46-50	1	57.0	57.0	57

Table 9: Work Experience Vs. MSD Symptoms

Work Experience (years)	**No. of Drivers**	**Overall CMDQ Result** ***(Freq x Severity x Work Interference)***		
		Average	**Min**	**Max**
2-5	9	29.2	0.0	93.00
6-9	3	20.2	19.5	21.00
10-13	3	84.0	27.0	174.00
14-17	1	57.0	57.0	57.00
18-21	4	55.9	18.0	81.00

The data shows a definite relationship between age and working experience to the development of MSD of the drivers. As exhibited in Table 8 and Table 9, drivers with age 36 years and above and those with more than 10 years of working in this field yield the highest result indicating prevailing MSD symptoms amongst these groups.

4. Conclusions

The result of the study indicates that 80% of the drivers experienced ache, pain, and discomfort occurring 1-2 times per week are primarily on the lower extremity parts of the body (foot, legs, thighs, knees)

and back region. Although the pain felt on these body parts was reported as slightly to moderately uncomfortable, work interference is still notable. These mainly were experienced within the age group of 36 and above and those working for more than 10 years. Furthermore, the result of postural analysis (REBA score between 4.0-7.0) recommends that further investigation and improvement on how the job is design must be implemented soon to provide a better working environment for the drivers.

Thus, professional driving is evidently part of the vulnerable occupational group, considering many ergonomic studies that exhibited the same results and recommended immediate ergonomic intervention [9]. It can complement the result of this study that professional driving in the logistics sector in the Philippines can certainly pose a risk in developing a musculoskeletal disorder (MSD) over time. Likewise, results are not very different from the studies on drivers working in transportation (jeepney, bus, taxi) and other logistics sectors (trucking, freight forwarding). Based on related studies, drivers in these sectors started experiencing pain in the same body region: hips, legs, and thighs. Similarly, postural analysis using REBA or RULA (Rapid Upper Limb Assessment) yields the same score of between 4.0-7.0, which means thorough investigation and change must be implemented soon [10]-[13].

5. Limitations and Suggestion for Further Studies

The study has the following limitations: (1) participants of the survey (sample size), and (2) inclusion of other predictive factors such as health conditions, healthy lifestyle, and behaviors [12], [14]. Expanding the sample size is needed to prepare an accurate statistical analysis that will show the relationship of other predictive factors to MSD development due to the nature of this job.

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