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Prevalence of Musculoskeletal Disorders in Automotive Manufacturing

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Abstract: Work-related musculoskeletal disorders are one of the largest contributors to lost workdays in the automotive industry. This paper will investigate the prevalence of lost workdays (general, musculoskeletal-related, and low back injury) across departments in an automotive manufacturing setting. Insurance data regarding health outcomes was clustered by departments and generalized linear models were used to test the effect of year and department on those health outcomes. Department was a significant factor in all but one metric. Further pairwise comparisons helped to identify which departments were significantly different. Despite notable limitations in the data due to privacy laws, the data indicated that office workers had the lowest rates of musculoskeletal disorders, while logistics and assembly departments had the highest rates. These results can be used to better target measures and interventions to help reduce the prevalence of musculoskeletal disorders.

Keywords: musculoskeletal disorders, interventions, automotive

1. Introduction

Work-related MSDs continue to be a leading source of lost workdays and associated costs, across all industries. In 2019 the costs of overexertion, exertion, and repetitive motion in the United States were estimated to exceed 18 billion dollars and comprise 33% of total workplace injury costs (*Liberty Mutual Workplace Safety Index*, 2019). For countries with a high socio-demographic index, the incidence rate of specific work-related MSDs (low back and neck pain) has even shown a slightly increasing trend between the years of 1990 and 2019 and are both within the top 25 causes for disability-adjusted life years in 2019 (Vos et al., 2020). Specifically, within automobile manufacturing, rates of work-related MSD symptoms reportedly range from 79% (both genders) to 98% (for women) performing blue-collar manufacturing tasks (Arghami et al., 2016; Ghasemkhani et al., 2006; Hussain, 2004). Targeting effective interventions typically begins with the identification of areas, departments, tasks, etc. which are highly associated with musculoskeletal disorders.

The purpose of this paper is to explore the prevalence of musculoskeletal disorders across the various departments involved in an automotive manufacturing setting, as it has developed over a period of three years. Results may indicate areas in which particularly high levels of musculoskeletal disorders are observed and may therefore be a more effective target for interventions.

2. Methods

Data were gathered from the annual health report generated by the internally managed, optional, public health insurance system offered by the automotive manufacturer. The reports for the years 2018, 2019, and 2020 were consolidated and departments matched. For the respective years, the data represent 24052, 25934, and 26344 persons who have opted in, of a total 31010, 33243, and 33808 persons. These data were then categorized into 7 departments, roughly representing the total manufacturing cycle (see Table 1).

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Table 1. Description of departments.

Department	Description of activity
Office	All office-based activities e.g., planning, steering, human resources
Logistics	Managing the flow of all parts from delivery in the plant to provisioning of parts on the line
Press shop	Stamping of metal parts for the car body
Body in white	Welding of the car body
Paint shop	Painting the car body
Motor assembly	Assembly of various engines (internal combustion, electric, hybrid, etc.)
Assembly	Full assembly of car through to final inspection

Data were extracted from the reports for the number of lost work cases per 100 insured years, lost days per 100 insured years, and number of days per case, for the outcome categories of general lost work cases, general musculoskeletal disorders (MSD), and lower back injury (LBI). This resulted in nine sets of health outcome data.

Minitab 19 was used to calculate general linear models to determine the effect of year and department on health outcomes. Given that the main effect of department was significant in eight of nine models, post-hoc Bonferroni-corrected pairwise comparisons were performed to determine significant differences between departments. Significance was concluded at $p<0.05$.

3. Results

General linear models indicated that department was a significant predictor of all health outcomes in eight of nine cases, while year was only significant in three models (see Table 2).

Table 2. Total degrees of freedom (DoF) and *p*-values for main factors in the general linear models. Significant values are highlighted in bold.

		Factor	
Health outcome	**Total DoF**	**Department**	**Year**
Lost work cases per 100 insured yrs.	208	**<0.001**	**<0.001**
Lost work days per 100 insured yrs.	208	**<0.001**	0.301
Lost days per case	208	**<0.001**	**0.001**
MSD cases per 100 insured yrs.	181	**<0.001**	0.111
MSD lost days per 100 insured yrs.	182	0.087	0.212
MSD lost days per case	182	**0.003**	**0.039**
LBI cases per 100 insured yrs.	157	**<0.001**	0.703
LBI lost days per 100 insured yrs.	158	**<0.001**	0.879
LBI lost days per case	158	**<0.001**	0.374

Results of the post-hoc comparisons revealed that office workers generally had significantly lower prevalence of negative health outcomes, for general, MSD, and LBI, while logistics and assembly departments generally had higher levels of negative health outcomes, when compared to the other departments (see Figure 1).

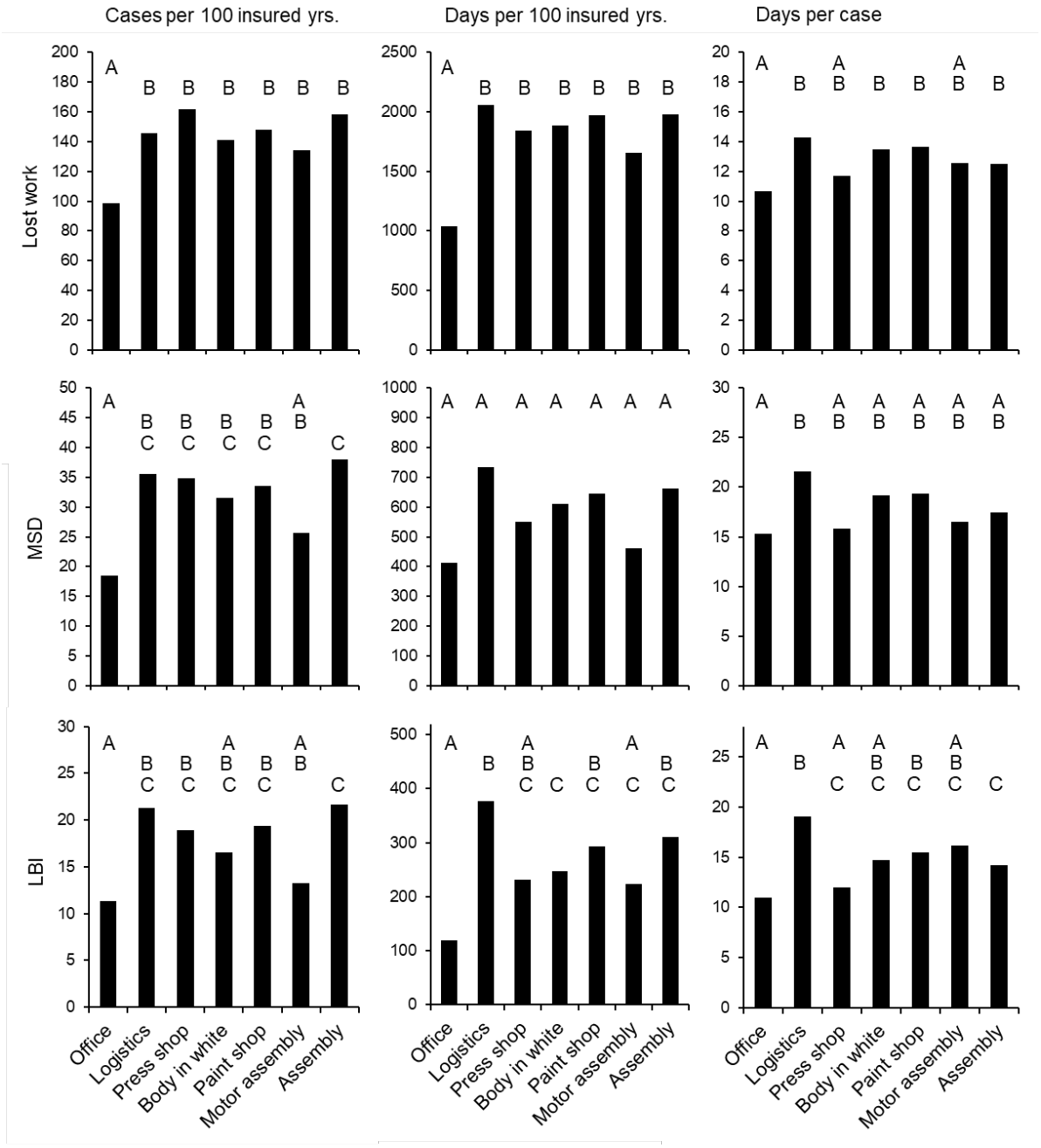

Figure 1. Mean values for all departments for all nine health outcomes. Results of the post-hoc comparisons are indicated above the respective department. Means that do not share the same letter are significantly different.

4. Discussion & Conclusion

The purpose of this investigation was to determine whether different departments in an automotive manufacturing setting had significantly different rates of negative health outcomes. To answer this question, insurance data relating to negative health outcomes (general, MSD, and LBI) were compared across departments and years for a major automotive manufacturer.

Unsurprisingly, the effect of department was significant, with office workers having the lowest prevalence of negative health outcomes in all categories. This is expected since office workers are typically exposed to less physical stress, meaning

their likelihood of experiencing a negative health outcome is lower. Likewise, departments associated with high physical stresses, such as logistics and assembly, had a high prevalence of negative health outcomes. Logistics is involved in moving and provisioning all sorts of parts, meaning there are high levels of manual material handling. Similarly, in the assembly department, the entire interior of the car is assembled, which includes cabling, seats, motor, etc. and involves a significant amount of time in poor postures.

The investigation here is not without limitations. One major limitation is the possibility for confounding in the health outcome variables (insurance data). The insurance outcome variables here may include MSDs from sources other than employment, e.g. private, second job, etc. This effect cannot be minimized as the data gathered by the insurance company purposely has no information regarding the possible source of the MSDs (due to privacy), meaning that some of the MSDs included here may have resulted from personal factors. Further, due to the optional nature of this insurance, only about 78% of the workforce opt into coverage. Consequently, those persons not represented in the data may have a different distribution of health outcomes.

The results of this study can help determine which departments may benefit most from interventions, given varying rates of negative health outcomes. Further, the results indicate that different approaches may be needed due to the varying levels of health outcomes between departments.

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