An Atlas Injury Prevention Solutions White Paper

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Relationship between Material Handling, Demographics, and Discomfort in the Transportation Industry

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Introduction

How well do we understand the link between the person, the role of material handling, and the onset of discomfort within the transportation industry? This white paper will investigate the relationship using data provided by 102,749 drivers.

Overview & Data Collection

Data was collected from a subset of transportation industry clients served by Atlas over a 10-year period (2008-2017).

Definitions

A review of the terms used during the analysis and development of graphs.

Participants

There were 102,749 drivers evaluated for the study. The characteristics of the population involved in the study are presented.

Demographics and Material Handling vs. Discomfort

The relationship between the essential material handling functions of the job, individual demographic data, and reported levels of discomfort are reviewed based on the data set. Recommendations on how the findings should impact an ergonomic assessment are provided.

Conclusions

A review of the relationships learned and primary considerations.

INTRODUCTION

According to an updated report in 2017 by the U.S. Bureau of Labor Statistics that reviewed injuries and illness in 2016, the transportation and warehousing industry sector had the 5th highest number of nonfatal injuries and illnesses in the private sector with approximately 210,300 reported (Figure 1). This resulted in drivers having the 2nd highest number of injuries with days away from work and the 5th highest incident rate in 2016[1] (Figure 2).

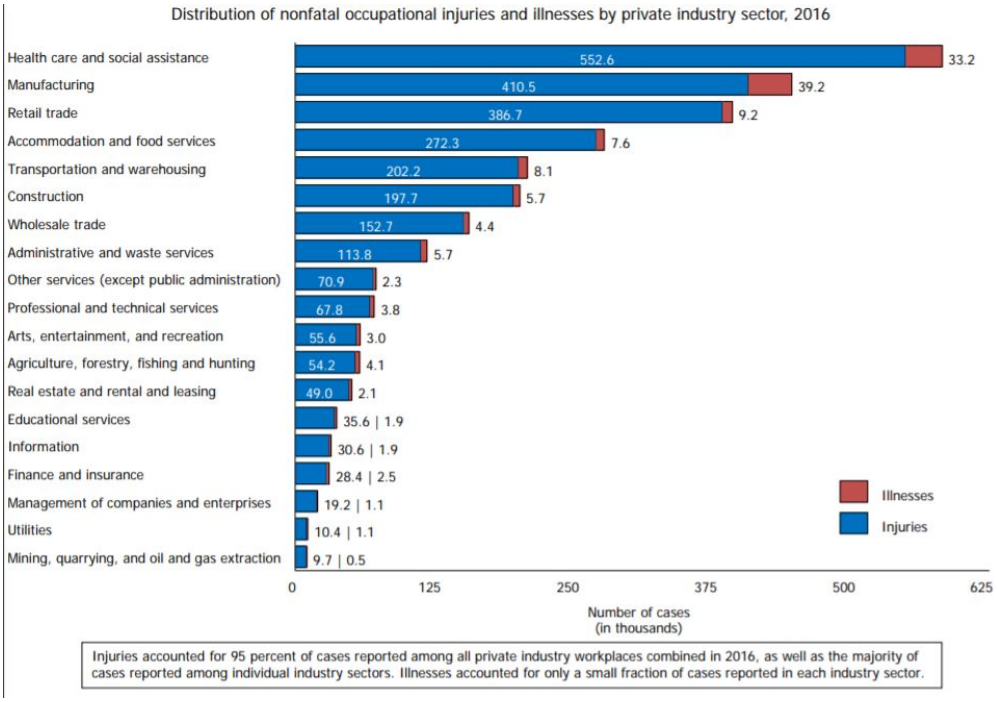


Figure 1: Distribution of Nonfatal Occupational Injuries and Illnesses by Private Industry Sector

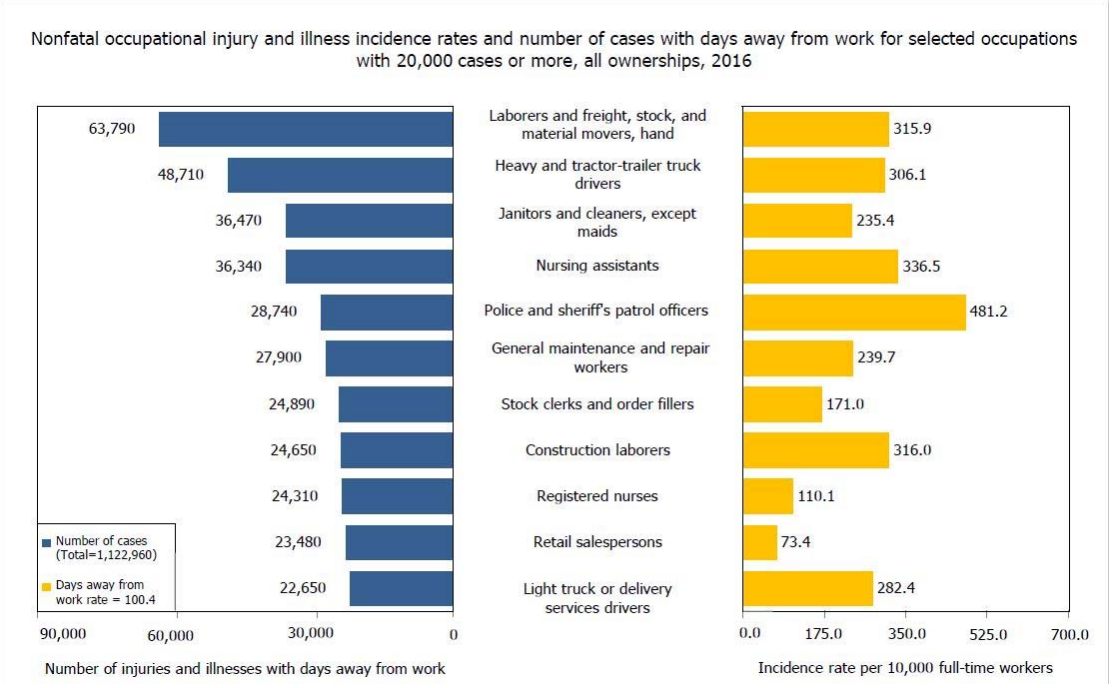


Figure 2: Nonfatal Occupational Injury and Illness Incident Rates and Number of Cases with Days Away from Work 2016

It is also worth noting that the availability of light-duty work in this industry is limited, causing most drivers to be fully recovered from an injury or illness before returning to work, unlike many office or factory settings where modified work can be accommodated.[2]

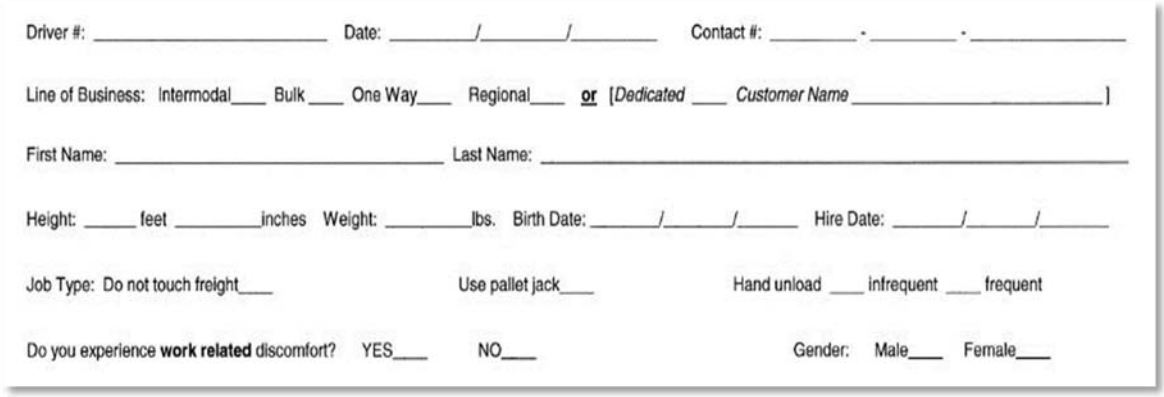
Given the above, it is important to explore the causes and define effective solutions to avoid injuries within the industry.

The purpose of this white paper is to continue our examination of driver discomfort from our first paper, *Relationship between Demographics and Discomfort in the Transportation Industry,* with a focus on the impact of material handling. Atlas has set out to define this relationship by using data collected through Job Demand Analyses (JDAs) of material handling categories and the results of discomfort surveys dispensed to drivers of a subset of Atlas clients. Using the data obtained and a review of the current research, our objective is two-fold:

- Assist the person in charge of avoiding and reducing injuries to identify and prioritize higher-risk drivers.
- Identify and justify recommendations through the analysis.

OVERVIEW AND DATA COLLECTION

Data collection was completed using Atlas' transportation discomfort survey. A survey is provided to collect basic demographical information, determine if the driver is experiencing discomfort, and define the level of discomfort. Figure 3 provides an example of the demographic section of the survey, where information such as gender, age, height, weight, and handling of freight are collected.



Driver #: _____ Date: _____/_____/_____ Contact #: _____-_____-_____

Line of Business: Intermodal___ Bulk___ One Way___ Regional___ **or** [*Dedicated* ___ *Customer Name* _____]

First Name: _____ Last Name: _____

Height: _____ feet _____inches Weight: _____lbs. Birth Date: _____/_____/_____ Hire Date: _____/_____/_____

Job Type: Do not touch freight___ Use pallet jack___ Hand unload ___infrequent ___frequent

Do you experience **work related** discomfort? YES___ NO___ Gender: Male___ Female___

Figure 3: Driver Demographic Information

Figure 4 provides an example of the discomfort section of the survey that is completed by a driver. Discomfort is assessed using a Health Index, which is the multiplicative value of the frequency and severity of symptoms, each on a 5-point scale. The Health Index is then used to rate discomfort by region of the body and the total discomfort the driver is experiencing.

Atlas uses an online database to collect the data for tracking and evaluation purposes.

ONLY IF you do experience **work related** discomfort: Please indicate the Location / Frequency / Severity of the discomfort (see below).

Location of Discomfort	Frequency of Discomfort					Severity of Discomfort				
	Never	Rarely	Occasionally	Frequently	Continuous	None	Minimal	Moderate	Significant	Intolerable
_____ Eyestrain	1	2	3	4	5	1	2	3	4	5
_____ Head & Neck	1	2	3	4	5	1	2	3	4	5
_____ Shoulders	1	2	3	4	5	1	2	3	4	5
_____ Elbows	1	2	3	4	5	1	2	3	4	5
_____ Wrists / Hands	1	2	3	4	5	1	2	3	4	5
_____ Upper Back	1	2	3	4	5	1	2	3	4	5
_____ Lower Back	1	2	3	4	5	1	2	3	4	5
_____ Hips / Thighs	1	2	3	4	5	1	2	3	4	5
_____ Knees	1	2	3	4	5	1	2	3	4	5
_____ Ankle / Feet	1	2	3	4	5	1	2	3	4	5

Figure 4: Location, Frequency, and Severity of Discomfort

DEFINITIONS

In order to complete the study, it was necessary to process the discomfort data and present it in formats that aided in viewing the potential relationships. Three key measures of discomfort were used:

Raw Discomfort Scores: The frequency and severity scores are measured on a 5-point scale. The answers provided by the driver are multiplied together to provide a score termed the Health Index. This raw score provides a measure of the discomfort for a single body part.

Prevalence of Discomfort: In order to find how many drivers are reporting discomfort overall and within each group, the prevalence of discomfort was found. This was calculated by finding the percentage of drivers that answered yes to the question: “Do you experience work related discomfort” on the driver discomfort survey.

Average Regional Discomfort: In order to compare differences between groups, an average Health Index of each body region was calculated.

Average Total Discomfort: In order to compare differences between groups, an average of the total discomfort scores across all drivers in the group was calculated.

Significant Difference: When comparing differences between groups, a T-test is used to compare the averages of the groups (mean). A probability value (p-value) is found to determine if the differences between the means are significant or are more likely due to chance. A significant difference would have a p-value <.05 or a less than 5% chance that the differences are due to chance alone. Therefore, when a significant increase or decrease is described below, the data demonstrates a p-value <.05.

In addition to these measures of discomfort, the data within this paper has been formatted to provide the most effective means of conveying a message. Additional descriptions of the methods used to create the graphs and format the data will be described as necessary.

PARTICIPANTS

This study included a population of 102,749 drivers who completed an online discomfort survey. These drivers were from a subset of transportation industry clients served by Atlas over the 10-year period of 2008-2017. The figures below give a breakdown of the participants' demographic data.

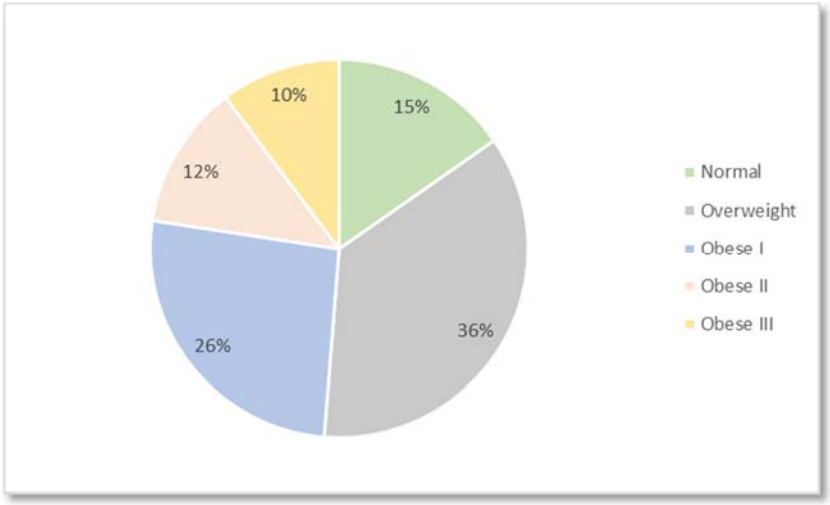


Figure 5: BMI Distribution

Figure 5 presents the breakdown of the study population based on body mass index (BMI). This data demonstrates a higher incidence of obese and overweight drivers in our population in comparison with information reported by the Center for Disease Control (CDC)[3]. The CDC found an incidence of obesity in the U.S. of 38% as compared to the study's finding of 48%. Also, the CDC found 71% of people either overweight or obese in comparison to the study's finding of 85%.

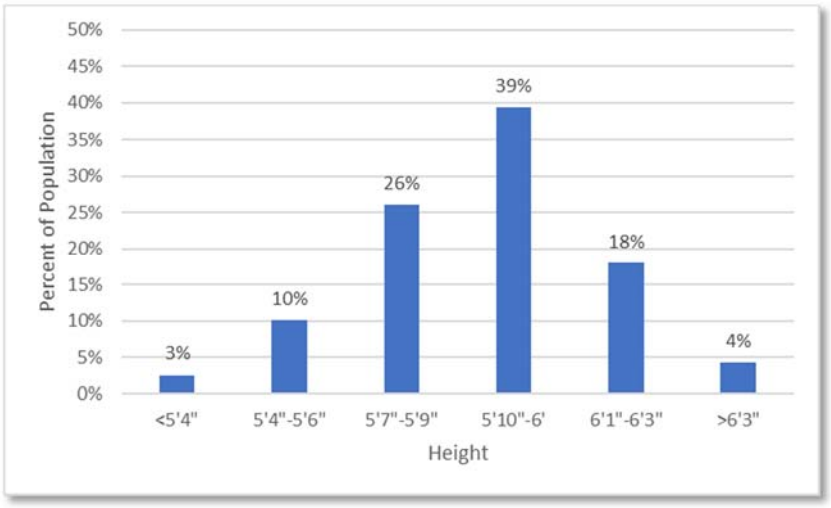


Figure 6: Height Distribution

Figure 6 presents the breakdown of the study population based on height. The figure shows a slight skew in the data toward taller height ranges, but it is not far from a normal distribution.

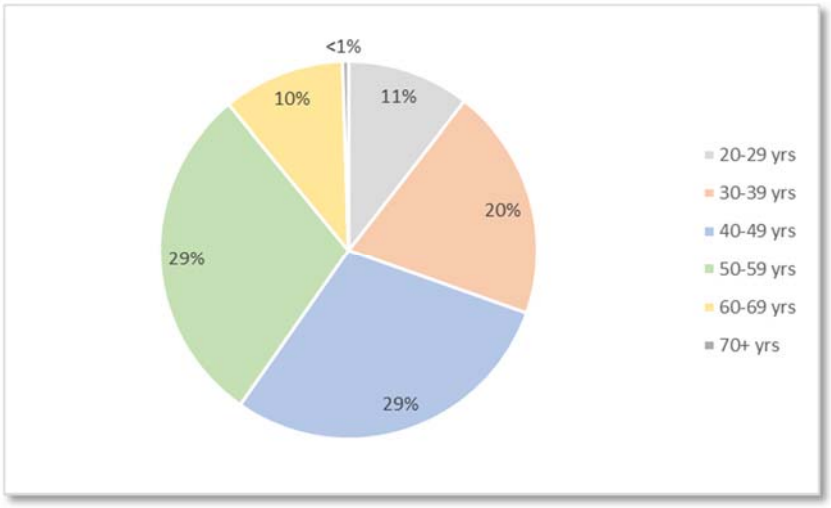


Figure 7: Age Distribution

Figure 7 presents the breakdown of the study population based on age with the largest segments in the age groups of 40-59 years old.

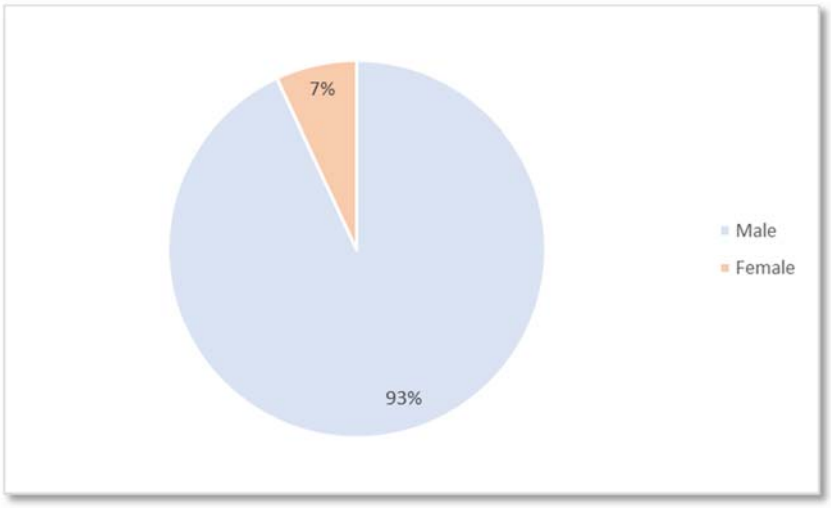


Figure 8: Gender Distribution

Figure 8 presents the breakdown of the study population based on gender. Male drivers represent 93% of the total number of participants.

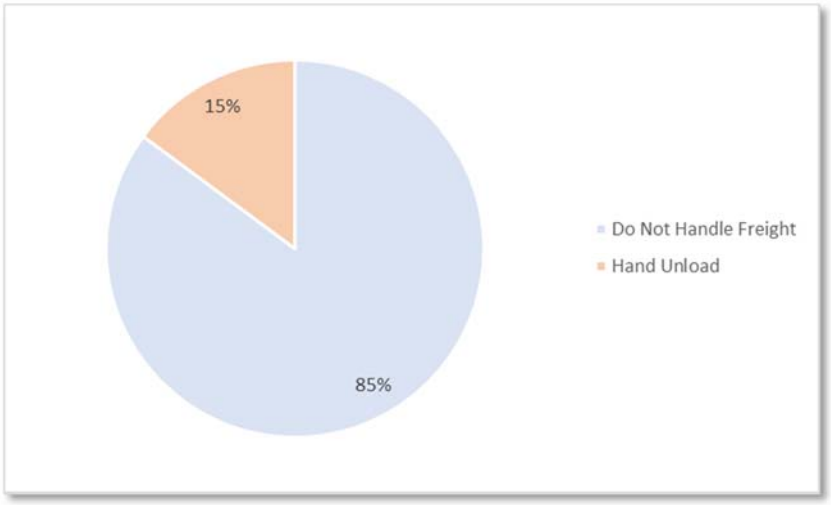


Figure 9: Material Handling

Figure 9 presents the breakdown of the job demand of handling freight. Fifteen percent of the drivers within our initial data set are required to hand unload their freight (material handling).

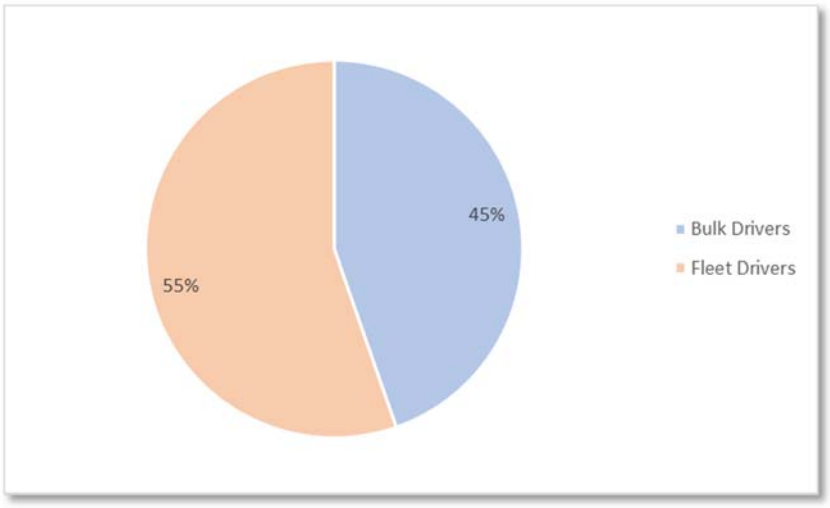


Figure 10: Type of Material Handling Driver

Figure 10 represents the breakdown of the types of drivers within the material handling group. By splitting the drivers into groups based on their frequency and intensity of material handling, we can further examine the relationship of each to demographic categories and driver discomfort.

Forty-five percent of the material handling group are bulk or tank truck drivers. Bulk drivers handle a higher amount of weight but less frequently. These drivers must handle 20-foot sections of hoses in order to unload their product. The hoses can weigh up to 70 lbs. with product.

Fifty-five percent of the material handling group are fleet drivers who generally handle a less amount of weight but with higher frequency. Fleet drivers typically unload freight from a 53-foot trailer that typically ranges from 10-30 lbs., and generally does not exceed 50 lbs.

DEMOGRAPHICS AND MATERIAL HANDLING VS. DISCOMFORT

As a starting point, Figure 11 demonstrates that of the 102,749 drivers who completed the online discomfort survey, 46% report having discomfort.

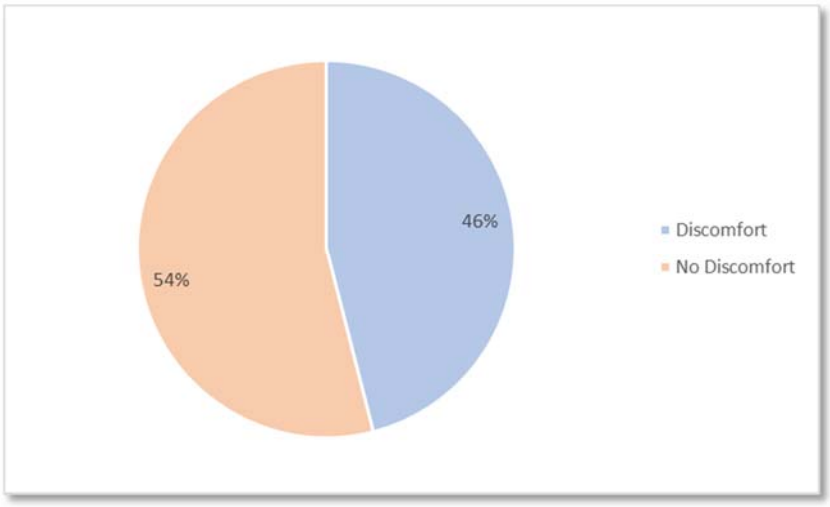


Figure 11: Prevalence of Discomfort

To support our analysis, we divided the drivers into three groups:

- Non-material handling drivers
- Fleet drivers: drivers who handle freight at a higher frequency (could exceed 1000 touches per work day) but at lower weights
- Bulk drivers: drivers who handle freight at a lower frequency (often does not exceed 50 touches per work day) but at higher weights

It is important to note that the frequency and weights of each job category were confirmed through JDAs performed for clients by Atlas. The purpose of a JDA is to review the essential functions of each job and measure the physical demands of those functions. Although drivers of all categories have similar essential function and physical demands, and therefore a risk of injury, the above categories were formulated based only on the physical demands of material handling[5].

It could be hypothesized that drivers whose jobs do not require material handling should have a lower overall prevalence and total average discomfort. However, Figures 12 and 13 demonstrate that this is not the case. Fleet drivers and the non-material handling group demonstrate a significantly higher prevalence of discomfort and average total discomfort than the bulk drivers.

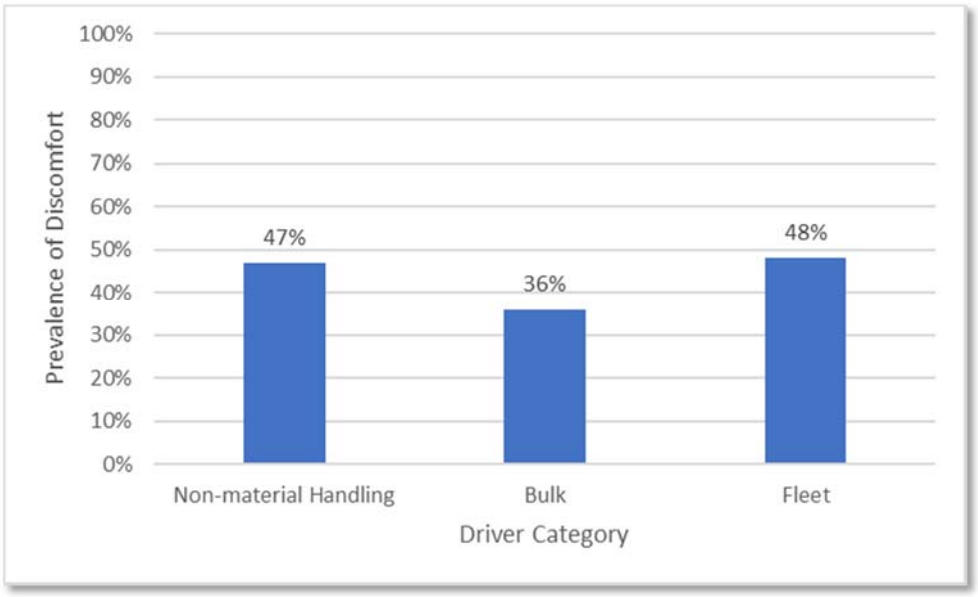


Figure 12: Prevalence of Discomfort by Driver Category

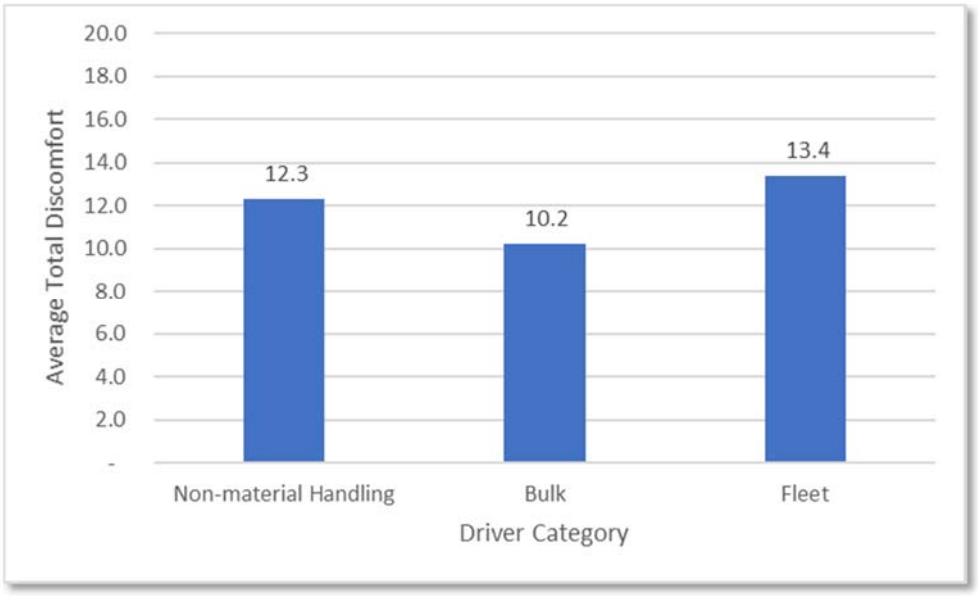


Figure 13: Average Total Discomfort by Driver Category

As was discussed in the first paper in this series, drivers report the highest prevalence and average total discomfort in three body regions: low back, head/neck, and shoulders. Figure 14 demonstrates the prevalence of discomfort for those body regions for each driver category.

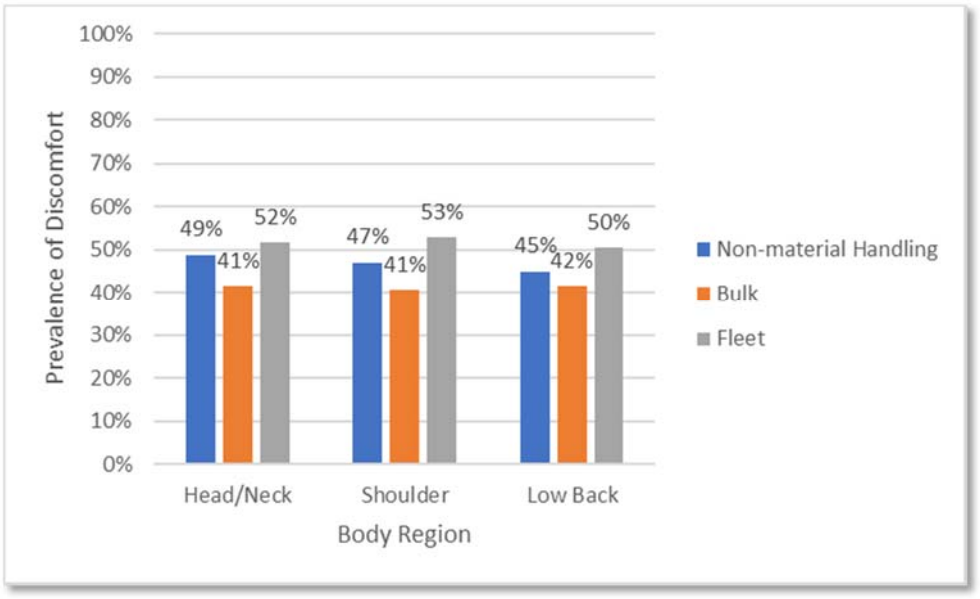


Figure 14: Prevalence of Regional Discomfort by Driver Category

As the data is examined further to look at the total average discomfort in these body regions, there is one significant finding. Figures 15-17 demonstrate that fleet drivers have the highest levels of discomfort in their low back, head/neck, and shoulder regions. This data leads us to believe that drivers who are handling lighter weight with higher frequency have both a higher prevalence and average level of discomfort.

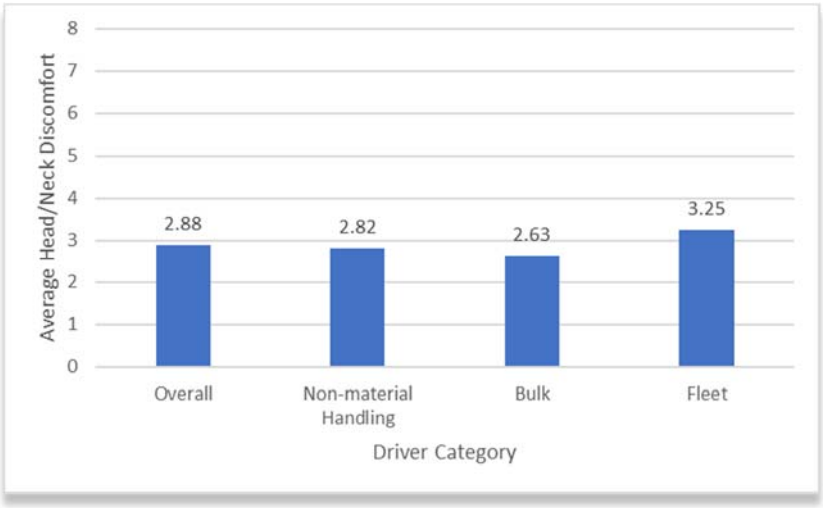


Figure 15: Average Head/Neck Discomfort vs. Driver Category

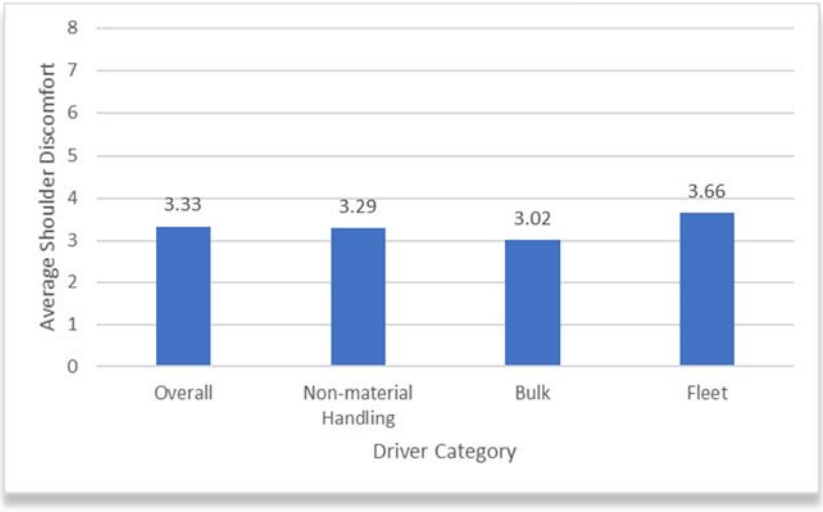


Figure 16: Average Shoulder Discomfort vs. Driver Category

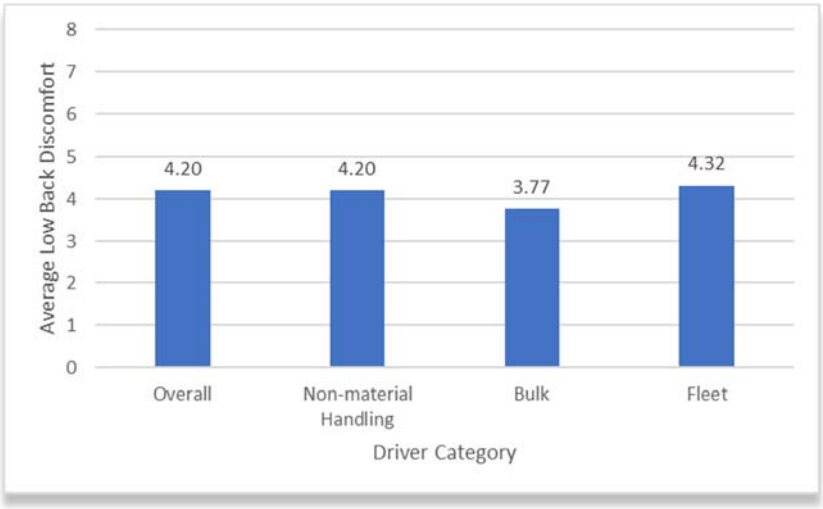


Figure 17: Average Low Back Discomfort vs. Driver Category

IMPACT ON APPROACH

While material handling demands of fleet drivers involves lower product weight, the frequency of their lifts over the workday increases the likelihood of fatigue and the development of discomfort over time. Training regarding maintenance of joint mobility and muscle recovery through warm up and stretching, appropriate work pacing, and proper lifting techniques can effectively lessen the impact of their material handling and maintain comfort and productivity.

Demographic Categories

When considering demographic characteristics of drivers, the first paper of this series found it important to consider three: height, BMI, and age. The relationship of each of these demographic categories, material handling job demands, and discomfort will be further analyzed.

Height

In the first paper of this series, Atlas discussed the following aspects of the effect of height on driver discomfort:

- Drivers of shorter stature (<5’4”) have a higher prevalence of discomfort and average discomfort than other drivers.
- Taller drivers (>6’3”) demonstrated a higher prevalence of knee pain than other drivers.

As a starting point for this study, Figure 18 demonstrates the height difference between the groups. Although there is a slight increase in the percentage of taller drivers in the groups that handle freight, the difference is not significant.

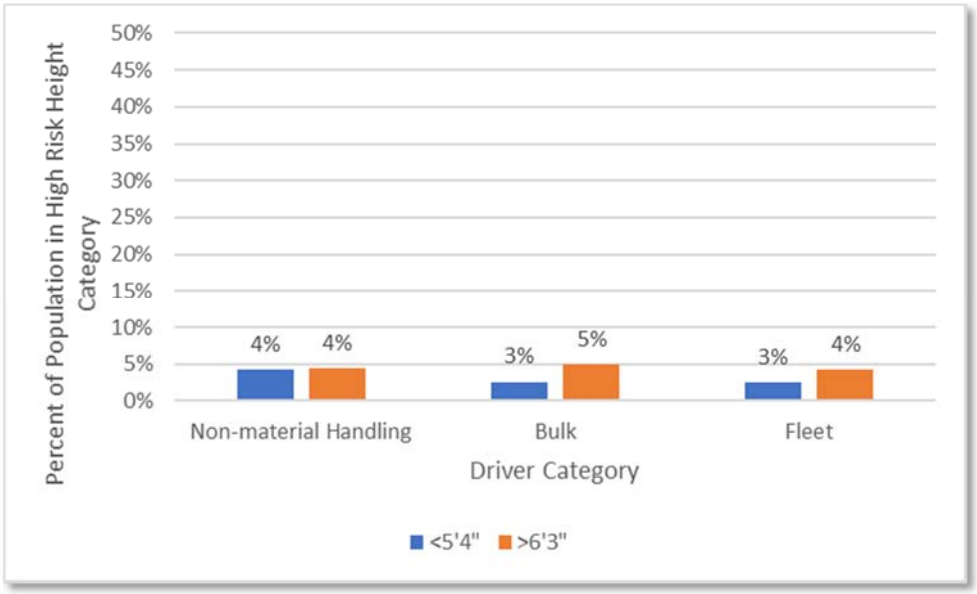


Figure 18: Percent of Population in High Risk Height vs. Driver Category

Figure 19 demonstrates a comparison of the prevalence of discomfort for each height and material handling category. It might be expected that there would be a higher prevalence of discomfort with shorter and taller drivers, but there is no significant difference in prevalence between average and the two height extremes. However, there is a correlation seen between prevalence and height. The prevalence of discomfort increases as height increases in both non-material

handling and bulk drivers. Height has no effect on prevalence of discomfort in fleet drivers.

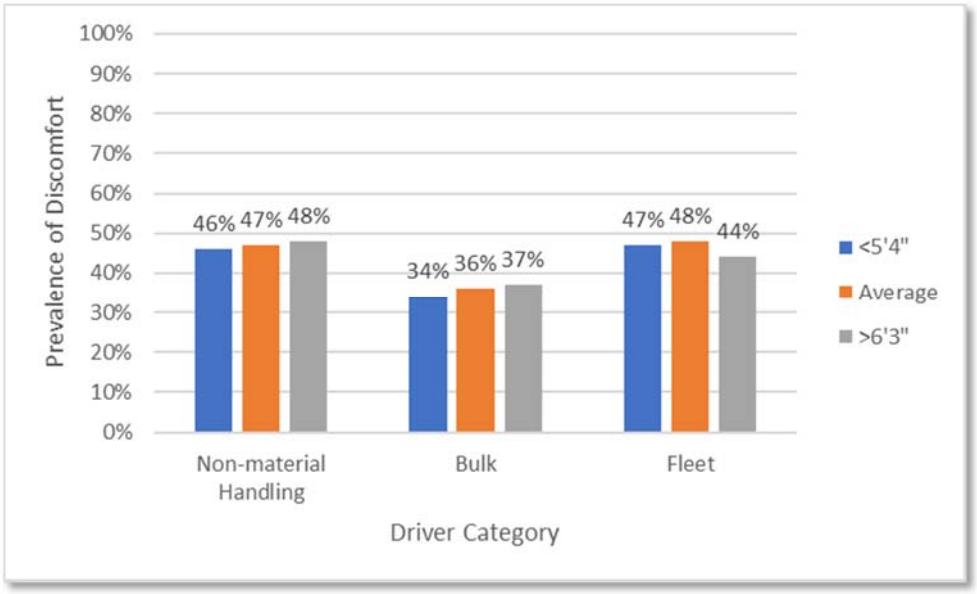


Figure 19: Prevalence of Discomfort vs. Driver Category

Figure 20 compares the percent change in average total discomfort between the shortest and tallest height categories and average height drivers. The data shows that shorter bulk drivers have a significantly higher average total discomfort than all other groups when compared to the average.

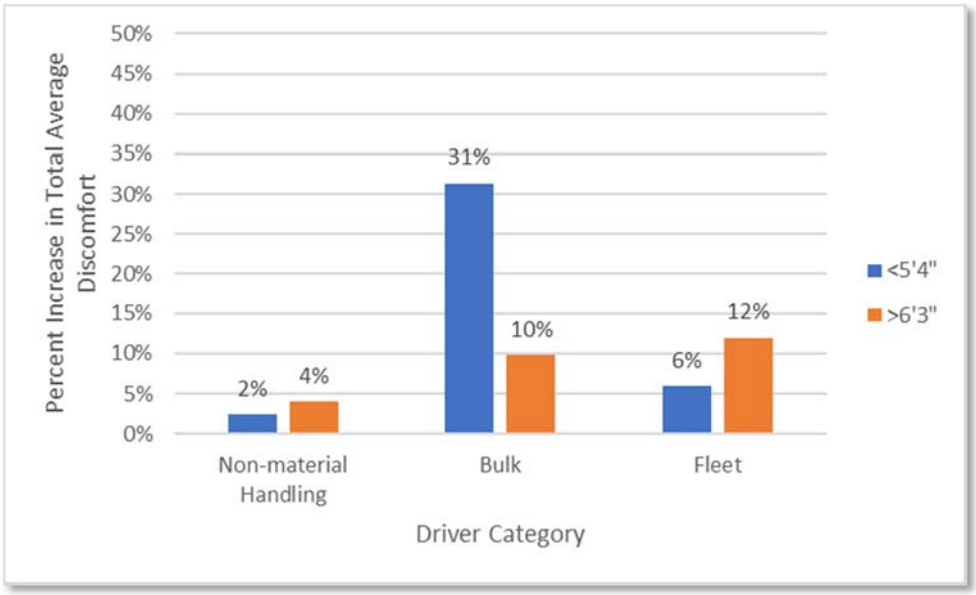


Figure 20: Percent Increase in Average Total Discomfort vs. Driver Category

When considering regional body discomfort, there were different findings between the taller and shorter driver populations. Figure 21 demonstrates the significant increase in regional discomfort seen in shorter bulk drivers in their head/neck, shoulders, and lower back.

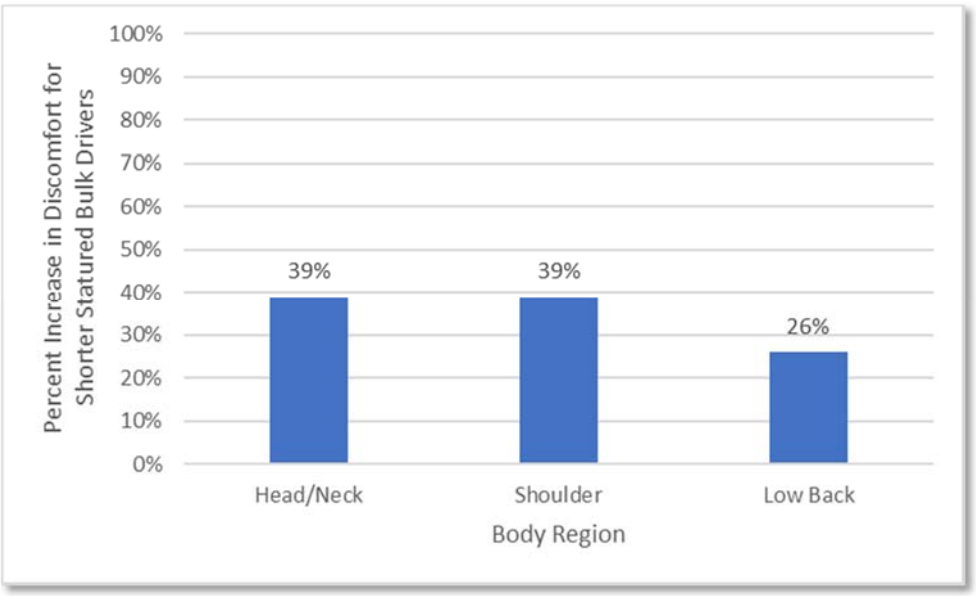


Figure 21: Percent Increase in Discomfort for Shorter Statured Bulk Drivers Over Average Height and Fleet Drivers vs. Body Region

In contrast, taller drivers were not as significantly impacted by driver category. Across each of the categories, only regional knee discomfort demonstrated a significant change. Figure 22 demonstrates that taller drivers have a significant increase in knee discomfort throughout the driver categories, with the greatest increase seen in bulk drivers.

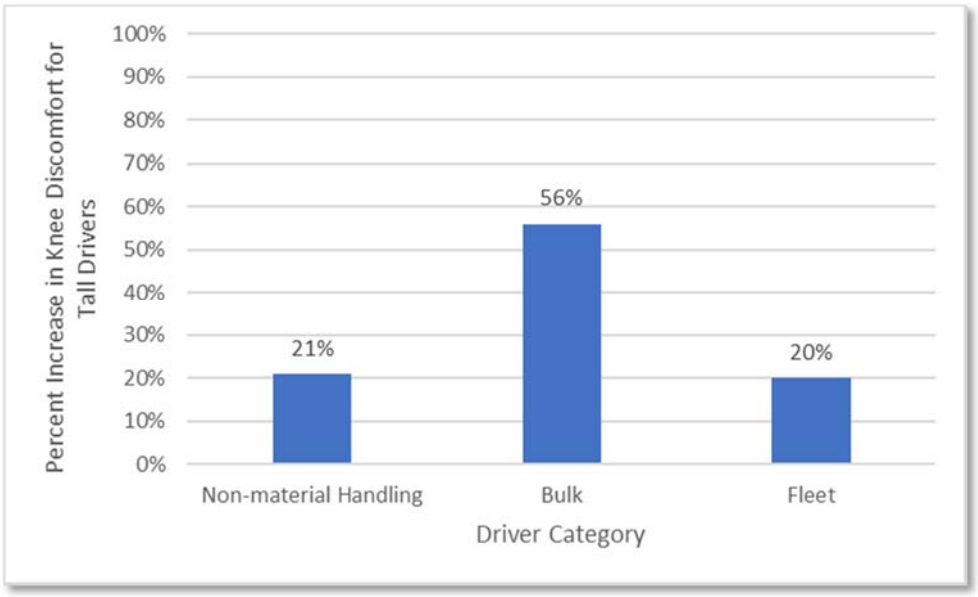


Figure 22: Percent Increase in Knee Discomfort for Tall Drivers Over Average Height Drivers vs. Driver Category

IMPACT ON APPROACH

The unique demands on a bulk driver demonstrate the most significant effect on drivers outside the range of 5'4" to 6'3". Shorter bulk drivers exhibit significantly higher average discomfort in their head/neck, shoulders, and lower back body regions. Taller bulk drivers exhibit significantly higher average discomfort in their knees. The bulk driver material handling demands, such as hose storage on the side of a tank truck, working below the truck for product offload and on top of the tank truck for loading of product, bring a different challenge to shorter and taller drivers. Discussing this risk and body region focused training on mobility and muscle recovery through warm-up and stretching, body awareness, and proper lifting techniques are recommended.

BMI

In the first paper of this series, Atlas discussed the following aspects of the effect of BMI on driver discomfort:

- There is a progressive increase in discomfort as an individual's BMI increases.
- Special attention should be placed on the knee, low back, and head/neck body regions for obese drivers (BMI >30).

As a starting point for this study, Figure 23 demonstrates the percentage of drivers who are obese in each driver category. There is no significant difference between the groups.

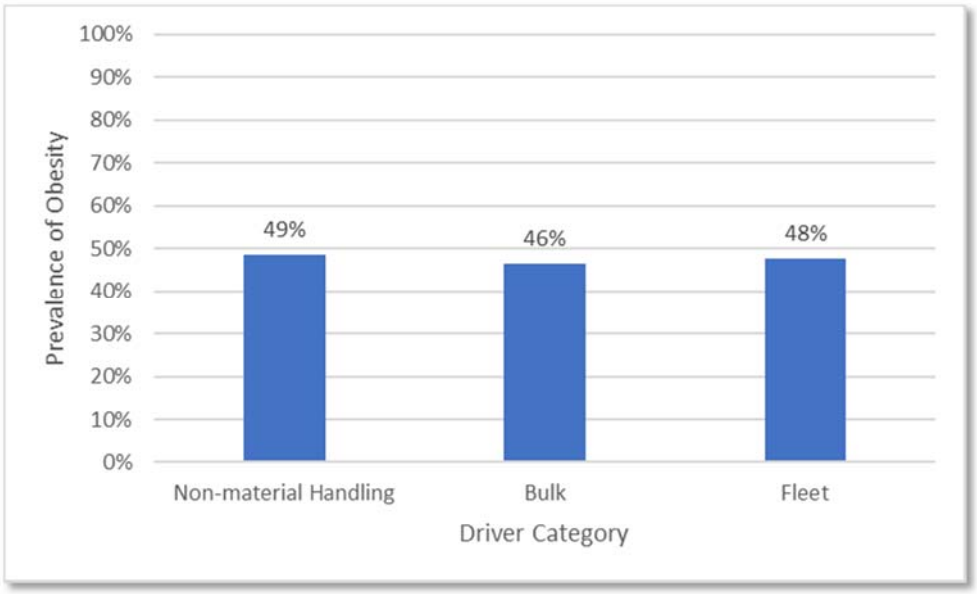


Figure 23: Prevalence of Obesity vs. Driver Category

Figure 24 demonstrates a comparison of the prevalence of discomfort between obese and non-obese drivers within material handling categories. Although we see a higher percentage of discomfort in obese drivers when handling freight, as was seen in our first paper, there is no significant difference between the groups or with the overall average.

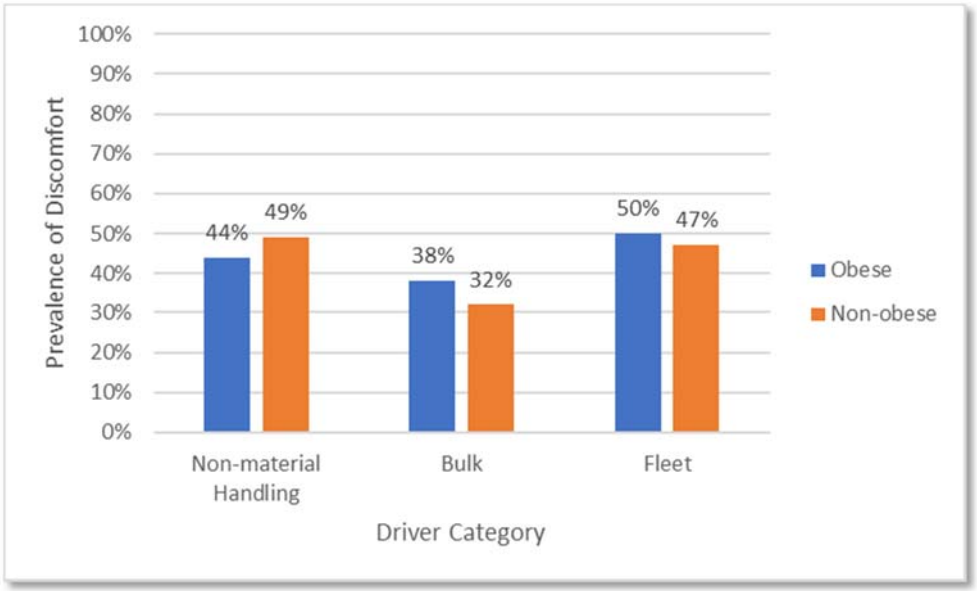


Figure 24: Prevalence of Discomfort vs. Driver Category

Figure 25 compares the increase seen in average total discomfort in obese drivers between the material handling categories. We see some increase in average total discomfort in all categories for obese drivers, but a significant increase in fleet drivers.

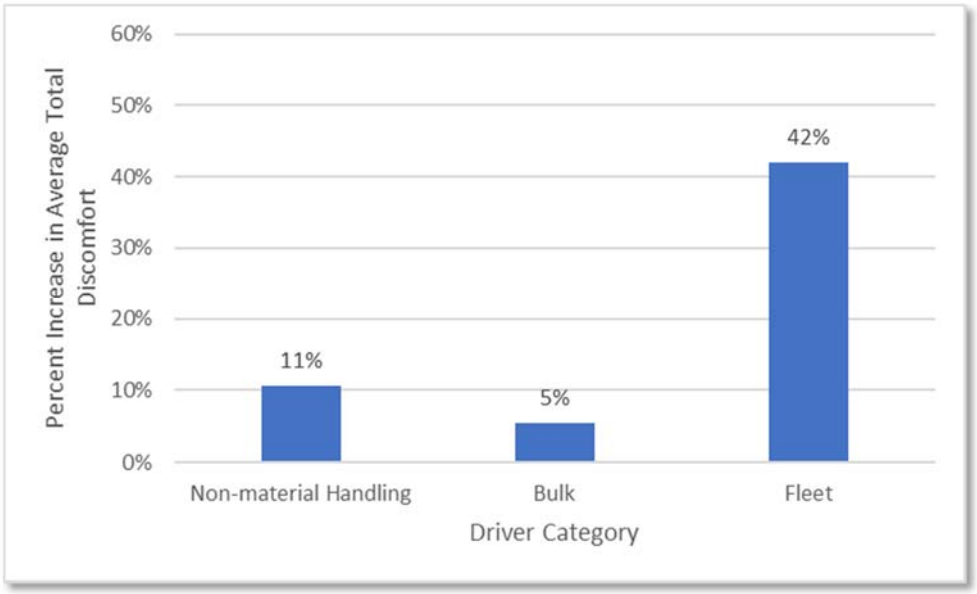


Figure 25: Percent Increase in Average Total Discomfort vs. Driver Category

Although the data analysis has shown that particular focus should be placed on the head/neck, low back, and knees in the obese population, material handling does not play as large of a role as expected. Driver category has no significant effect on the head/neck or low back in the obese population. Figure 26 demonstrates that obese drivers have significantly higher average knee discomfort in all categories of drivers with the most significant increase seen in fleet drivers.

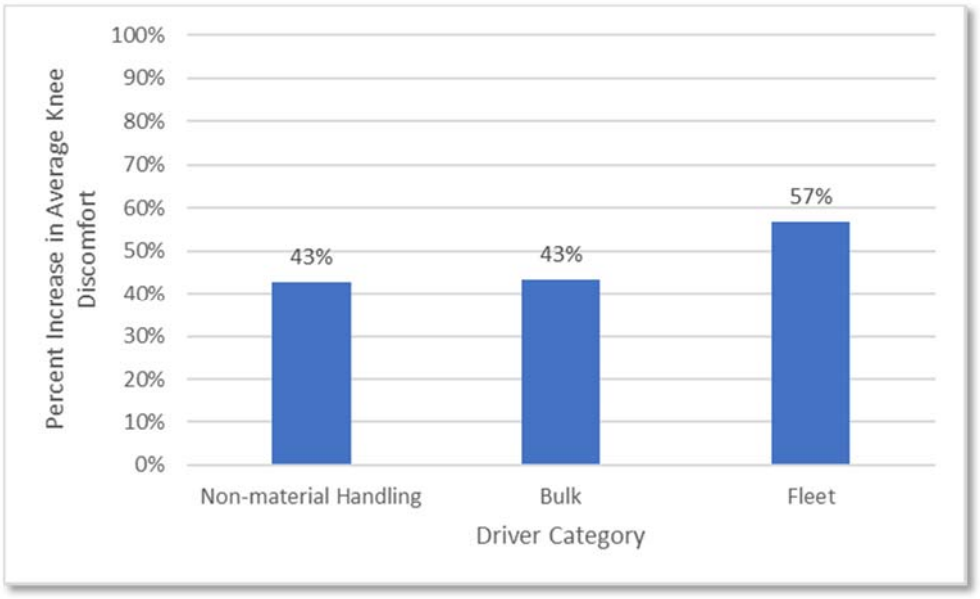


Figure 26: Percent Increase in Knee Discomfort vs. Driver Category

IMPACT ON APPROACH

Continue/expand health and safety programs for obese drivers to proactively address discomfort and provide extra focus on knees. Fleets should also consider the impact of a wellness program given the overall higher driver obesity rate. The program should focus on:

- **Exercise, given the limited facility resources**
- **The nutritional challenges of drivers**
- **A supported weight management program**

Our data suggests that higher repetition material handling had a higher effect on obese drivers in the fleet category. Special attention should be placed on proper training and weight management programs for obese fleet drivers.

Age

In the first paper of this series, Atlas discussed the following aspects of the effect of age on driver discomfort:

- There is an increased prevalence of discomfort as age increases.
- Younger drivers (20 – 29 years old) demonstrate a higher level of low back pain as compared to other drivers.

As a starting point for this study, we have grouped the drivers into two groups: younger drivers (40 years old and below) and older drivers (>40 years old). Figure 27 demonstrates that there is no significant age difference of the drivers between the driver categories.

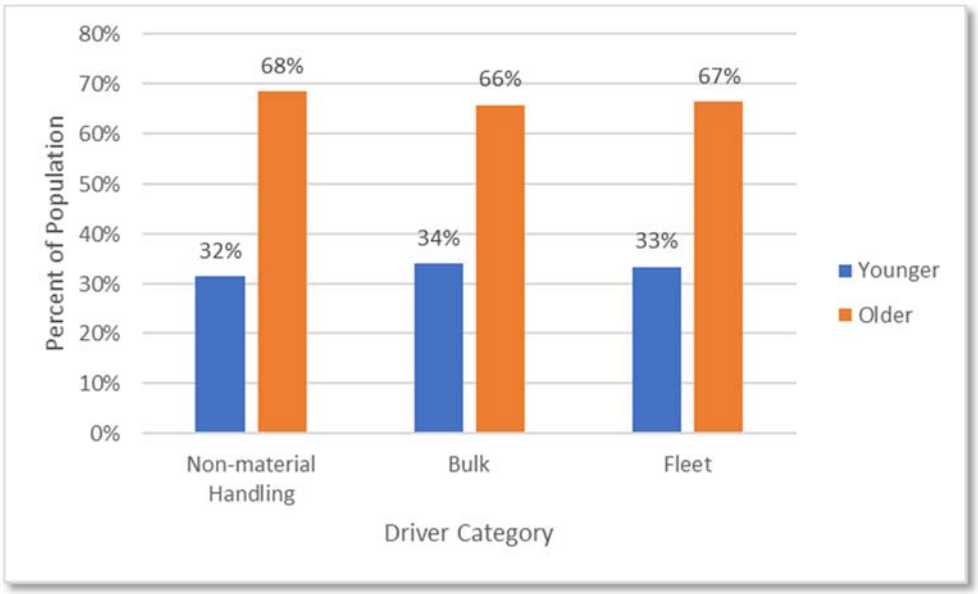


Figure 27: Percent of Population vs. Driver Category

Figure 28 demonstrates a comparison of prevalence of discomfort within the two groups for the driver categories. Older drivers generally demonstrate a trend of higher prevalence of discomfort in all material handling categories.

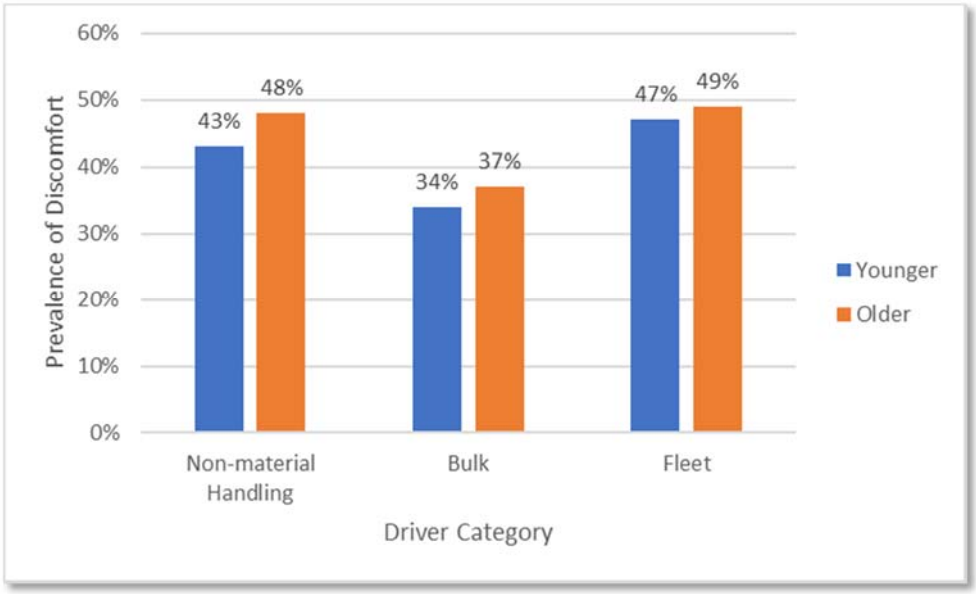


Figure 28: Prevalence of Discomfort vs. Age and Driver Category

Figure 29 looks at average total discomfort and demonstrates a different relationship. In material handling jobs, younger drivers report higher average total discomfort than older drivers, but the difference is not significant.

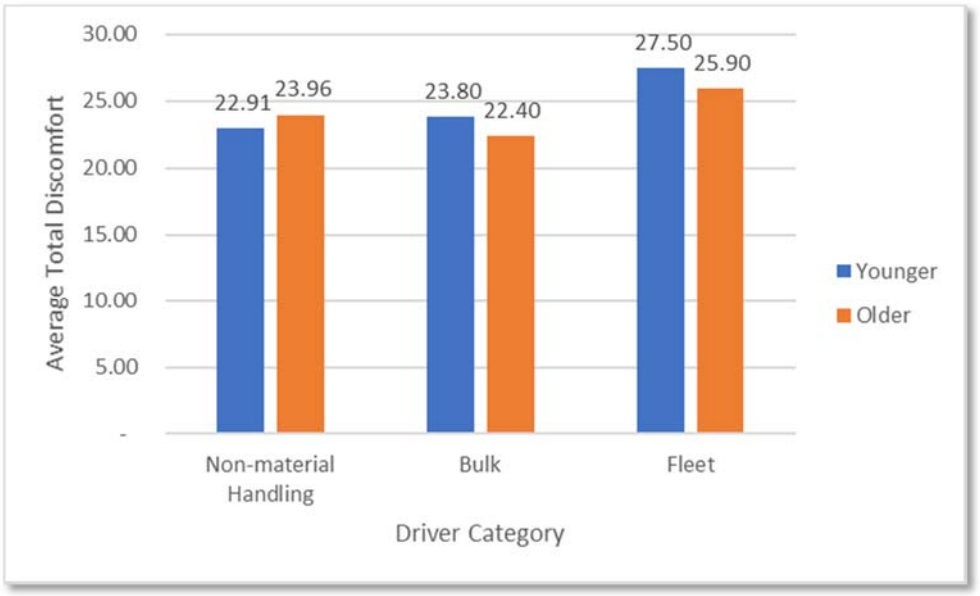


Figure 29: Average Total Discomfort vs. Age and Driver Category

We then focused on the discomfort of the three body regions of highest complaint: head/neck, shoulders, and low back. The data analysis demonstrates that the low back is the only region that has a significant difference between the ages. Figure 30 demonstrates the differences in regional low back pain by age category.

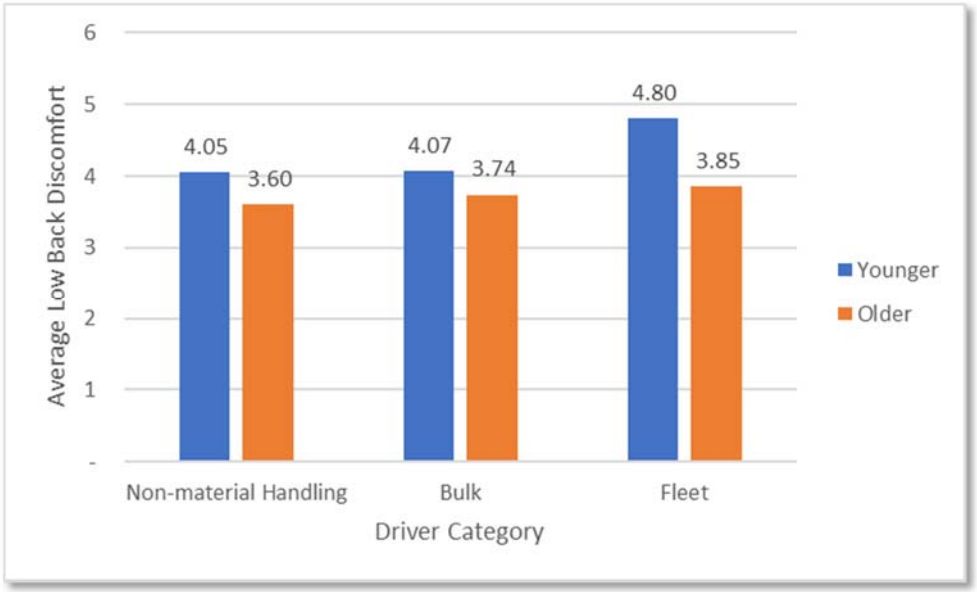


Figure 30: Average Low Back Discomfort vs. Age and Driver Category

The changes shown between age and driver category for head/neck and shoulder are not significant. However, there is a significantly higher level of low back discomfort seen in younger drivers in all material handling categories, but especially for fleet drivers. This demonstrates a larger concern for younger drivers in both material handling categories but even more of a concern when frequency is a factor (fleet) over the amount of weight itself (bulk).

IMPACT ON APPROACH

Older drivers report an overall higher prevalence of discomfort throughout all types of driver categories. However, younger drivers report higher average total discomfort and low back discomfort when handling freight. Targeting training and safety programs toward younger drivers provides an opportunity to accelerate their work expertise and understanding of safety risks. Since material handling requires additional physical effort, training should include recognizing signs of fatigue, pacing, and preserving good technique throughout their shift. In addition, younger drivers may benefit from follow-up training, review, and feedback to ensure their successful implementation of safe work practices at intervals beyond their date of hire.

CONCLUSION

This is the second paper of a series looking at discomfort trends within the transportation industry. Trends related to the demographic categories of height, BMI, and age and how they interact with material handling were analyzed through our data set of 102,749 drivers from a subset of transportation industry clients served by Atlas over the 10-year period of 2008-2017. Recommendations based on the findings are summarized below.

- **Driver Category/Essential Functions: The material handling demands vary between the three driver categories. Fleet drivers require handling less weight, but at a higher frequency. The accumulation of these lifts increases fatigue and the development of discomfort over time. Studies have shown that discomfort causes two concerns for drivers. First, drivers that are in discomfort tend to be more distracted during their work day, causing a greater amount of difficulty when responding and reacting while on the road. Secondly, discomfort also causes physiological changes to the way an individual works, causing the driver to compensate by using that region of the body differently. This can prolong discomfort and lead to injury[4].**

  Proper training can effectively lessen this accumulation of workload and maintain driver comfort and productivity. Training should include:
  - **warm-up and stretching**
  - **appropriate work pacing**
  - **proper lifting techniques**

- **Height: The height of the driver has the largest effect on average discomfort within the bulk driver category. There are specific job demands in this category that place drivers outside the range of 5'4" to 6'3" at greater risk. Taller bulk drivers have a higher average knee discomfort than other drivers, whereas shorter bulk drivers demonstrate higher average head/neck, shoulder, and low back discomfort. Although the overall prevalence is lower in bulk drivers than is seen in fleet drivers, the significant increase in average amount of discomfort is alarming and can be a sign of injury development.**

Proper training can effectively lessen this accumulation of awkward positions and heavier material handling, which will improve driver comfort and productivity. Training should include:

- **warm-up and stretching**
- **body awareness and limitations**
- **proper lifting techniques**

- **<u>BMI</u>: As stated in our first paper, there is a need for a continuation and expansion of health and safety programs for obese drivers to address discomfort and potential safety concerns. It is important to revisit the findings of multiple studies on the transportation industry that state the following:**
  - **There is significantly higher average BMI in truck drivers than in the general population, more than twice the population's average.**
  - **The higher BMI is contributed to lifestyle choices, the sedentary nature of the job, poor diet, and fewer hours of sleep[5].**

  Prevention and wellness programs should be of highest priority in the transportation industry. Program development efforts should prioritize the knee, but also include the total body. Particular attention should be placed on the drivers in the fleet category due to the excess joint workload from the weight and repetition in the material handling. Wellness programs should be directed to address the high incidence of obesity in the transportation industry.

- **Proper training and educational programs should be put in place to assist with lowering drivers' BMI, reduce repetitive activities and loads on their joints through proper technique, and improve overall health awareness. Training should include:**
  - **Exercise with emphasis on lower body strength and flexibility, given the limited facility resources**
  - **support and education regarding the nutritional challenges of drivers**
  - **a supported weight management**

- **<u>Age</u>: Younger drivers tend to be more significantly affected by material handling. Although older drivers report a higher overall prevalence of discomfort, younger workers report a higher average total discomfort and low back discomfort when handling freight. These findings suggest that there is a learning gap between older and younger workers that must be addressed to decrease this trend.**

  Proper training can effectively lessen the learning gap between younger and older drivers, as well as give older drivers an approach

to decrease their discomfort during work activities. Training should include:

- **strategies that optimize body positioning**
- **strategies for interaction with equipment to minimize workload**
- **recognizing signs of fatigue to be able to control pacing and preserve good technique throughout their shift**
- **follow-up training to ensure their successful implementation of safe work practices**

The gathering of demographic data and having a complete understanding of the essential functions required for a job prior to completing an ergonomic assessment for drivers in the transportation industry is vital to understanding where emphasis needs to be placed. In addition to a survey similar to the one used by Atlas, a discussion with the employer and driver reviewing the essential functions of the job is helpful to the evaluator before they begin the assessment. With this information, the evaluator is better equipped to provide a more effective assessment and better solutions.

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