An Atlas Injury Prevention Solutions White Paper

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Relationship between Demographics and Discomfort in the Transportation Industry

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How well do we understand the link between the person and the onset of discomfort within the transportation industry? This white paper will investigate this using a data pool of 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 this project are presented.

Demographics vs. Discomfort

The relationship between 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

The transportation industry has been extensively researched over the past 20 years due to high incidence of fatal and nonfatal injuries incurred by truck drivers. Emphasis in the research during this time has been placed on fatal injuries. However, there has been a recent increase in research looking at lifestyle and demographic trends in truck drivers.

According to a 2016 U.S. Bureau of Labor Statistics report that reviewed injuries and illness between 2003-2012, there has been a downtrend in overall injuries in the transportation industry since the downturn in the U.S. economy (Figure 1). This trend leveled out during the recovery, but truck drivers continue to have the 6th highest incidence rate with over 8,000 non-fatal injuries reported in 2016[1]. (Figure 2)

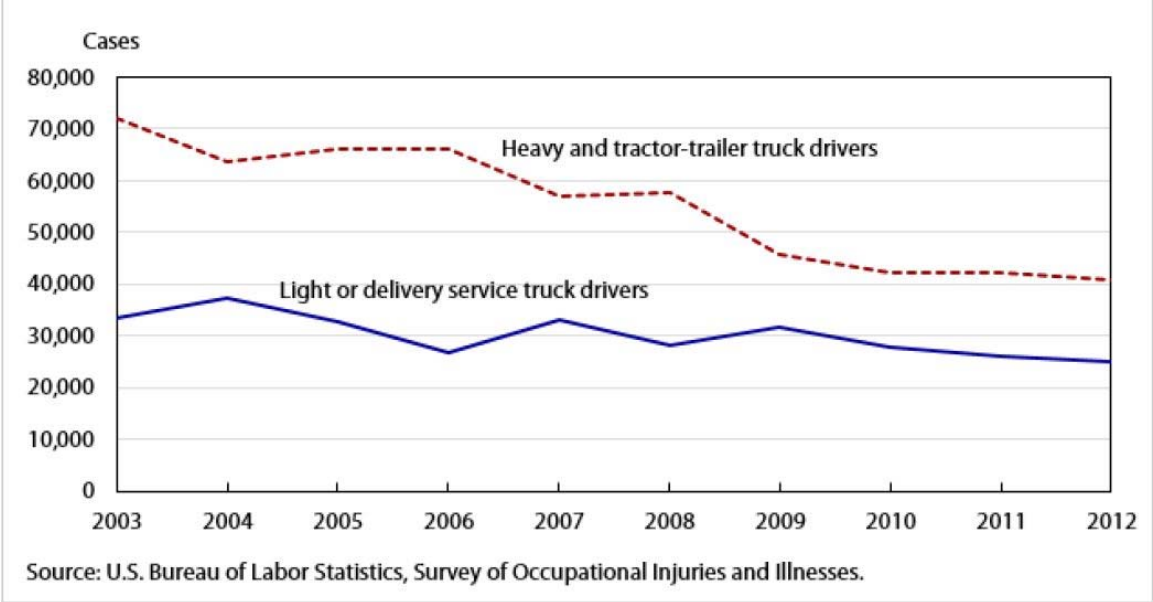


Figure 1: Nonfatal Occupational Injuries and Illnesses Involving Days Away from Work

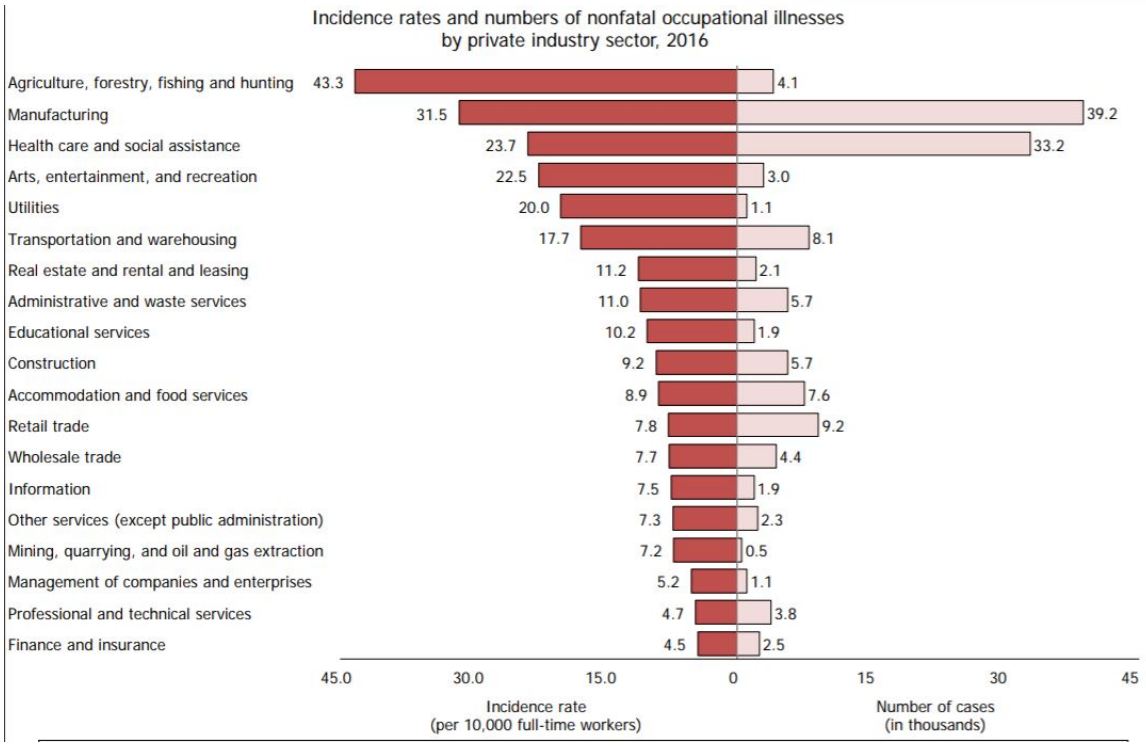


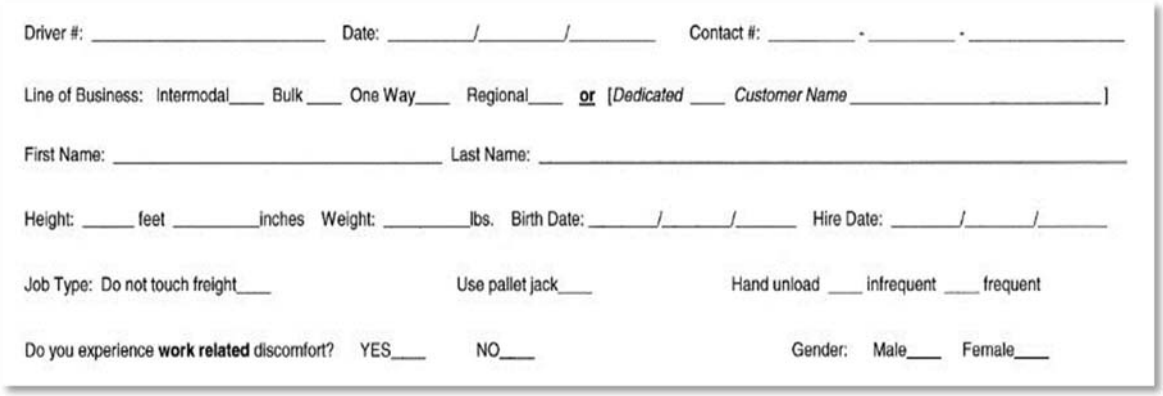
Figure 2: Incidence Rates and Numbers of Nonfatal Occupational Illnesses and Injuries by Private Industry Sector in 2016

The purpose of this paper is to compare reported demographic information with the reports of discomfort within the transportation industry. Atlas Injury Prevention Solutions (Atlas) has set out to define this relationship by using the results of a survey dispensed to employees of a subset of transportation industry clients served by Atlas. Using the information provided by these employees and a review of the current research, our objective is two-fold:

- Assist the person in charge of transportation safety and ergonomics to identify and prioritize higher risk employees
- Justify recommendations through data provided

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 employee 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: Employee Demographic Information

Figure 4 provides an example of the discomfort section of the survey that is completed by an employee. Discomfort is assessed using a Health Index, which a combination of frequency and severity of symptoms on a 5-point scale. The multiplicative value of these discomfort variables (Frequency x Severity) is used to rate the regions of the body and total discomfort the employee 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 compare driver demographics to discomfort, 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 to illustrate the interaction between demographics and discomfort:

Raw Discomfort Scores: The frequency and severity scores are measured on a 5-point scale. The answers provided by the employee 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.

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 employees in the group was calculated.

Other Definitions:

> **Correlation Coefficient (*r*)**: A measure of the strength and direction of the linear relationship between two variables. The value of *r* is always between +1 and –1. The correlation must be greater than +.50 or less than -.50 to be considered significant.
>
> **Positive Correlation:** An *r*-value greater than 0. A positive correlation exists when one variable decreases as the other variable decreases, or one variable increases while the other increases. An *r*-value of +1.00 is considered a perfect positive correlation.
>
> **Negative Correlation**: An *r*-value less than 0. A negative correlation is a relationship between two variables in which one variable increases as the other decreases, and vice versa. An *r*-value of -1.00 is considered a perfect negative correlation.

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 employees were from a subset of transportation industry clients served by Atlas over the 10-year period (2008-2017). The figures below give a breakdown of the participants' demographic data.

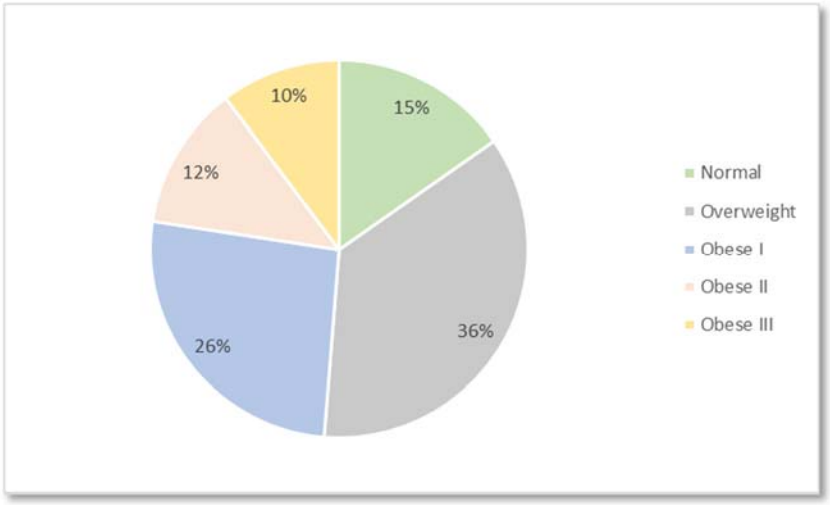


Figure 5: BMI Distribution

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 employees in our population in comparison with the information collected by the Center for Disease Control (CDC)[2]. 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%.

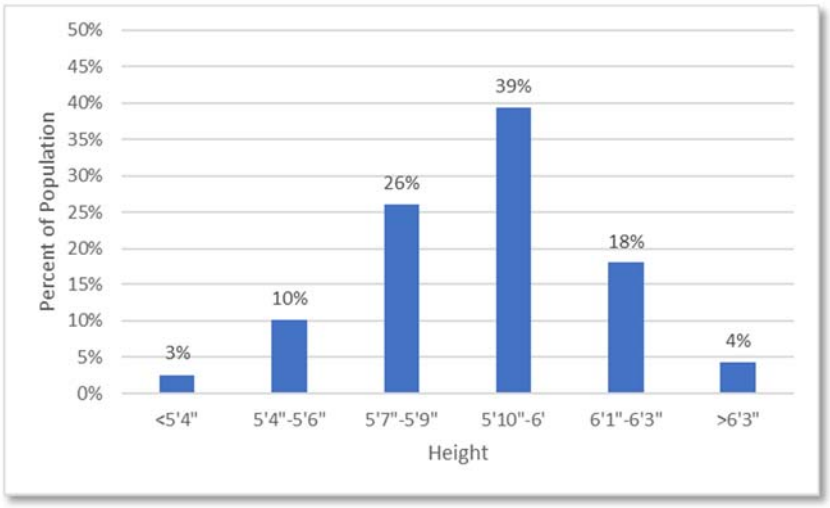


Figure 6: Height Distribution

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.

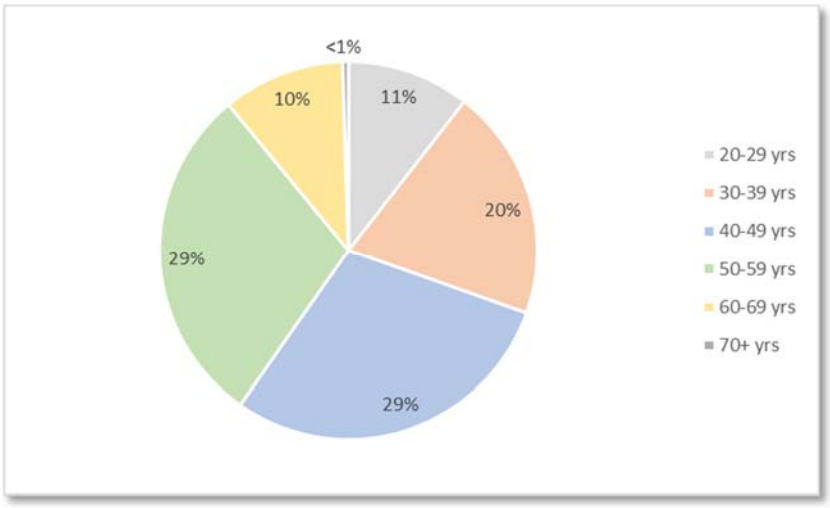


Figure 7: Age Distribution

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

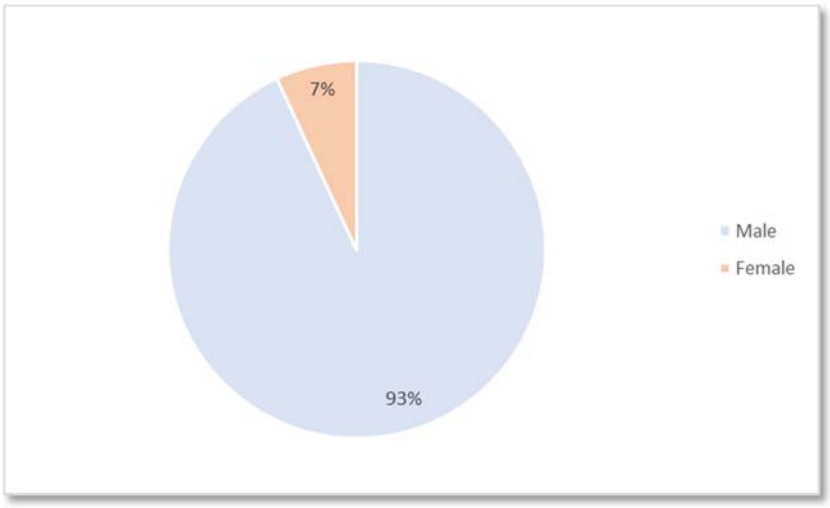


Figure 8: Gender Distribution

Figure 8 presents the breakdown of the study population based on gender. Male drivers represent greater than 90% of the total number of participants.

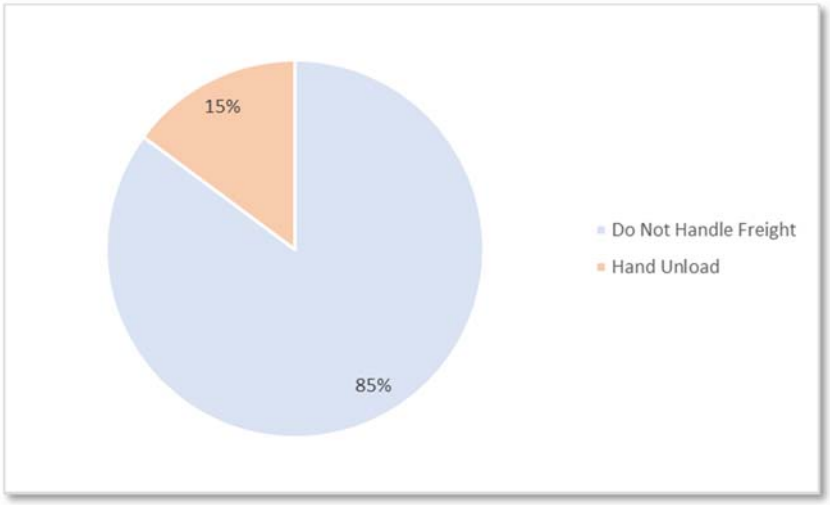


Figure 9: Material Handling

Figure 9 presents the breakdown of the job demand of handling freight. Only 15% of the drivers in this study are required to hand unload their freight (material handling).

DEMOGRAPHICS VS. DISCOMFORT

The purpose of this white paper is to compare reported demographic information with the reports of discomfort of truck drivers within the transportation industry. Figure 10 demonstrates that of the 102,749 drivers who completed the online discomfort survey, 46% report having discomfort.

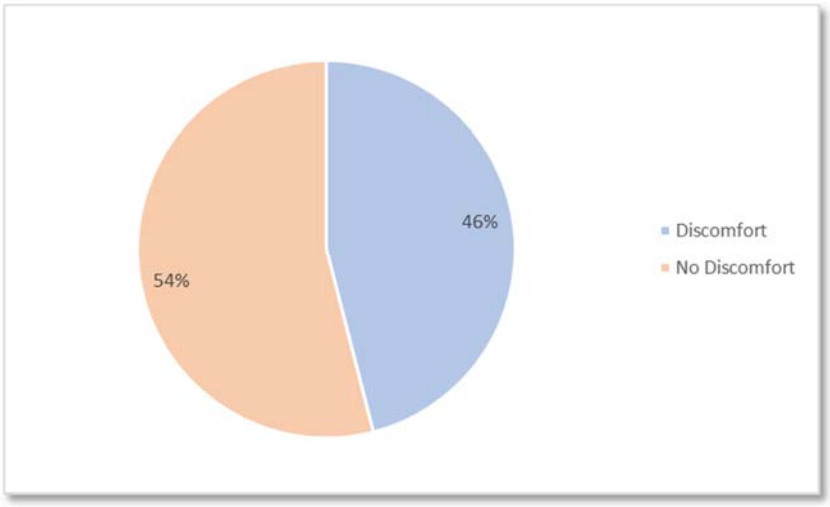


Figure 10: Prevalence of Discomfort

Prevalence of discomfort is a critical factor when addressing injury prevention. Discomfort can be a distracting force on the driver. A driver must make hundreds of decisions when on the road. The prevalence of discomfort can make it more difficult to respond and react, placing the driver at a higher risk for injury.

Discomfort also causes physiological changes to the way an individual works. In their 2017 article, Fella et al found that when an individual feels discomfort in a region of the body, it causes the body to alter the way it performs a task[3]. The findings of their study suggested, through use of electromyography (EMG), decreased muscle activity and changes in how the muscle activates are found in regions where the individual feels discomfort. In other words, the individual compensates by using that region of the body differently.

Compensation movements and altered muscle activity can perpetuate pain and lead to injury, especially when involved in repetitive work or prolonged postural positions. By knowing which workers are experiencing discomfort and where the discomfort is felt, prevention programs and ergonomic interventions can be used to target those workers at risk of injury.

As the data is examined further, Figure 11 demonstrates that the drivers who report discomfort have the highest levels of discomfort in their low back, head/neck, and shoulder regions.

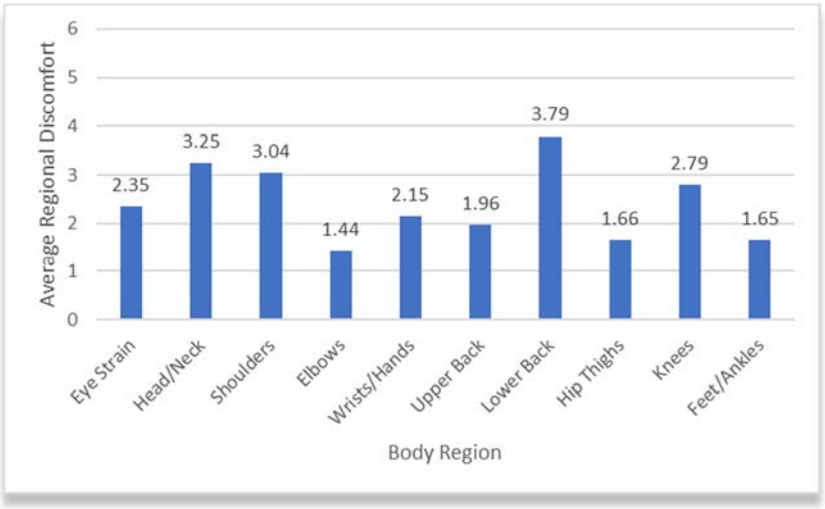


Figure 11: Average Discomfort vs. Body Region

When comparing demographic characteristics with driver discomfort, this paper is concentrating on four particular areas: height, BMI, age, and gender. Each demographic category will be further analyzed for the handling of freight. This is an integral aspect of the job that places increased stress on the driver and has been cited in research as one of the leading factors to the high incidence of injury within the transportation industry[4,5].

Height

Figure 12 demonstrates the prevalence of discomfort in each height category of the drivers. It would be expected that there would be a higher percentage of discomfort in the extreme levels (<5'4" and >6'3"). However, the only pattern that is seen is in the shorter statured drivers. The mean height of our data set is 5'10". As the height of the driver decreases from the mean, it correlates with a higher prevalence of discomfort (r=.96). On the other hand, as the height increases past the mean there in no correlation with prevalence of discomfort (r=0).

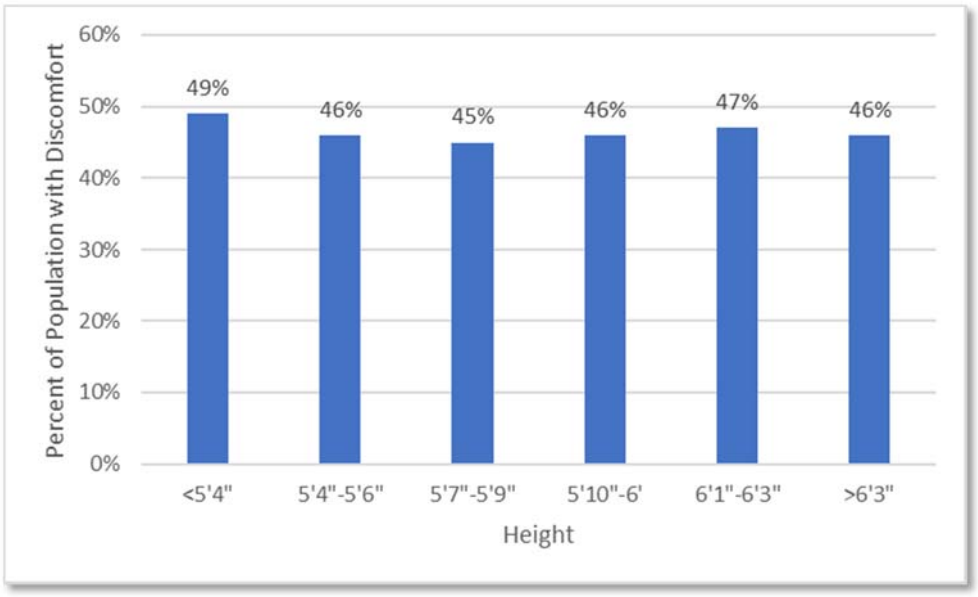


Figure 12: Percent of Population with Discomfort vs. Height

Figure 13 depicts the average total discomfort in each category of height. Unlike what was seen in the prevalence of discomfort, there is a definitive trend seen in both directions as you move away from the mean. As the employee's height moves away from the mean, there is a correlation between shorter stature (r=.93) and with taller drivers (r=.99) with higher average total discomfort.

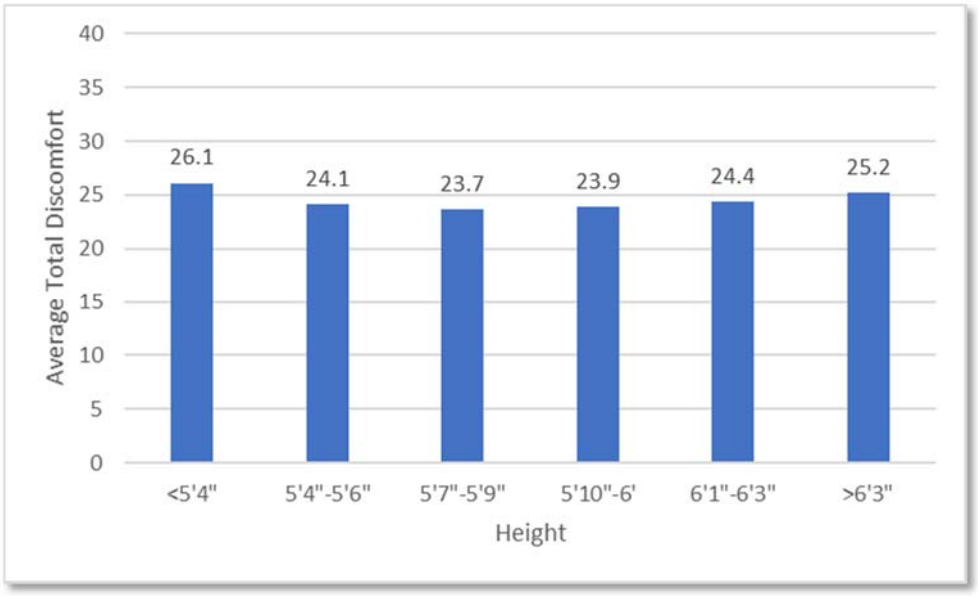


Figure 13: Average Total Discomfort vs. Height

There is also a change seen with employee height on which body parts are most affected by discomfort. In each group, the primary three areas of discomfort are low back, head/neck, and shoulder except in the tallest employees. Figure 14

demonstrates shoulder discomfort decreasing (*r*=-0.62) and knee discomfort increasing (*r*=.80) as the employee's height increases. In fact with the tallest employees, knee discomfort replaces shoulder discomfort as one of the top three areas of discomfort.

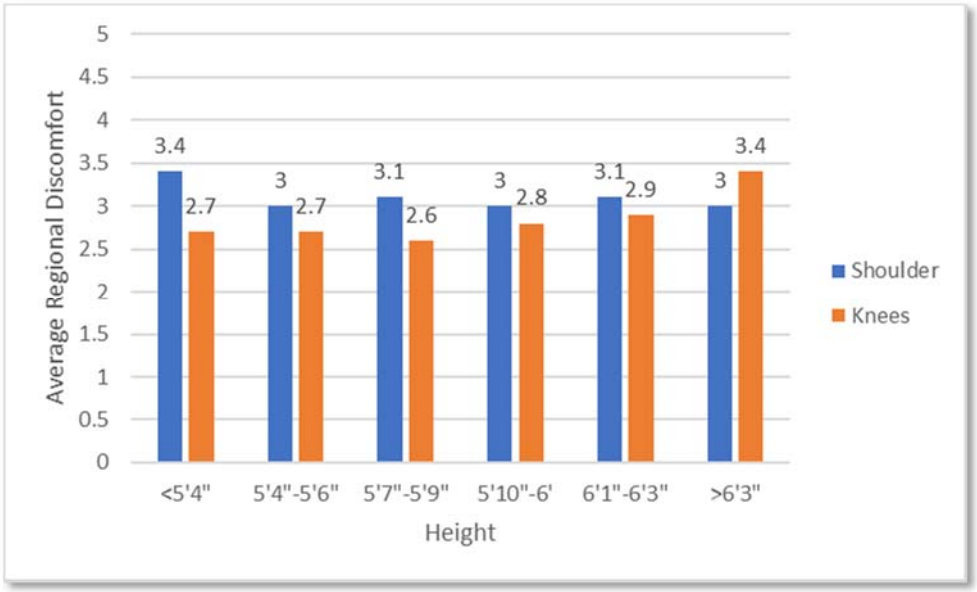


Figure 14: Average Regional Discomfort vs. Height

Effect of Material Handling

Material handling is one of the demands of the job that continues to be cited as a cause for the high injury rates seen in truck drivers. From the data we have collected, only 15% of drivers within our data set are handling freight. Figure 15 looks at the increase in prevalence of discomfort in each group. The most significant increase we see is in the tallest group of employees. However, if we look at average total discomfort, Figure 16, employees that are shorter than the mean of 5'10" report the highest average total discomfort.

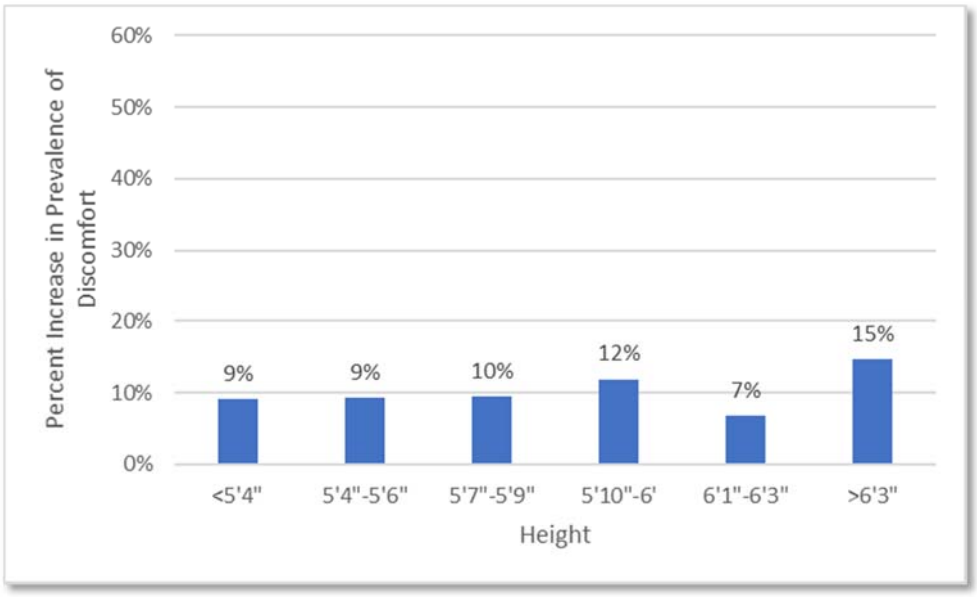


Figure 15: Percent Increase in Prevalence of Discomfort vs. Height for Material Handlers

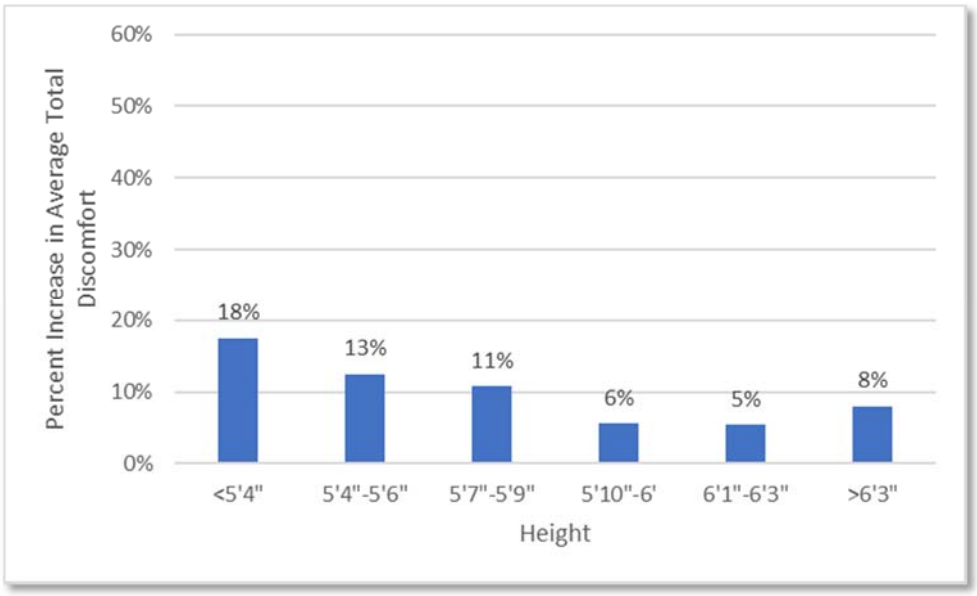


Figure 16: Percent Increase in Average Total Discomfort vs. Height for Material Handlers

When focusing our analysis on individual body regions, the only significant difference that is seen is in the low back. Figure 17 demonstrates that employees who are shorter than the mean have a higher level of low back discomfort when material handling.

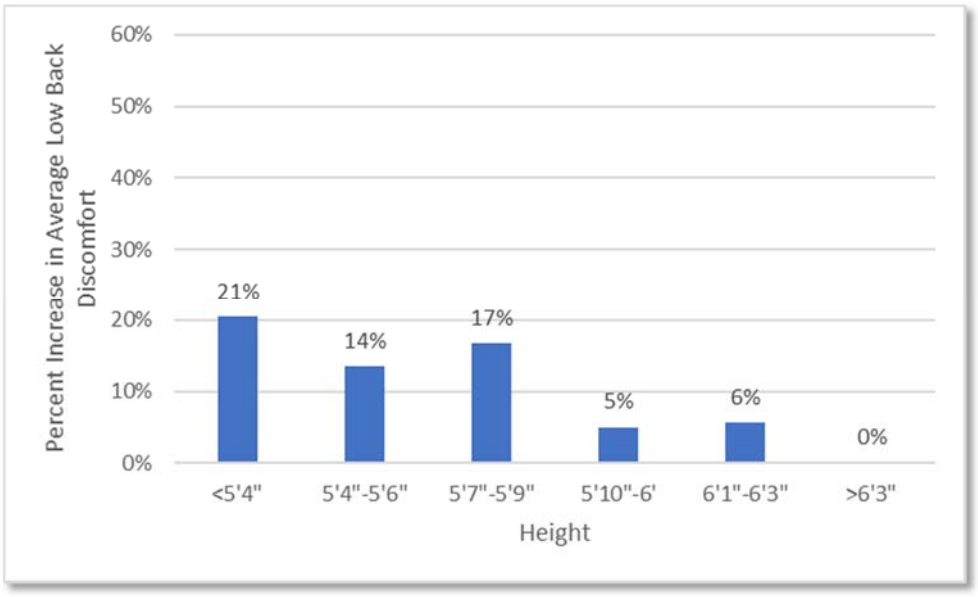


Figure 17: Percent Increase in Average Low Back Discomfort vs. Height for Material Handlers

IMPACT ON APPROACH

Emphasis should be placed on ergonomic cab modifications for individuals under the height of 5'4". Shorter drivers tend to have an increase in the required reach necessary to manipulate the steering wheel. These shorter statured individuals may benefit from an additive lumbar support which will effectively decrease the distance from the steering wheel to the seat back, thus reducing reach. For those shorter individuals who have material handling responsibilities, consideration of a 2-step platform will assist them with parcels that are located above head height.

Not surprisingly, taller drivers tend to be more cramped in the envelope of the cab of the truck. It is important to provide them the greatest amount of clearance and support possible: 1) make certain that the seat-slide is positioned in the furthest back position and 2) some drivers find benefit by engaging the Anterior Seat Tilt (raising the front edge of the seat relative to the back), providing a bit more room and support of their thighs on the seat itself.

Regardless, short or tall statured, proper line of sight should never be compromised when driving. It should be considered the primary factor in proper setup, followed by alternative positions to decrease the stress on the shoulders, neck, and back for shorter statured drivers and knees, neck, and back for taller drivers.

BMI

One of the most frequently referenced demographic categories in current research is the BMI of truck drivers. Multiple studies have found significantly higher average BMI in truck drivers than in the general population. Surveys have found obesity rates more than twice the population's average, contributing this to lifestyle choices, the sedentary nature of the job, poor diet, and fewer hours of sleep[5]. Our data found that 48% of the drivers were obese—26% higher than the national average from the CDC—and 85% of the drivers were overweight or obese—20% higher than the national average.

Figure 18 demonstrates the prevalence of discomfort within the classifications of BMI. There is a trend seen of increased prevalence of discomfort that correlates increasing BMI with an increased prevalence of discomfort (r=.97). This can also be seen in average total discomfort. Figure 19 demonstrates that as the BMI category increases, the average total discomfort does as well (r=.995)

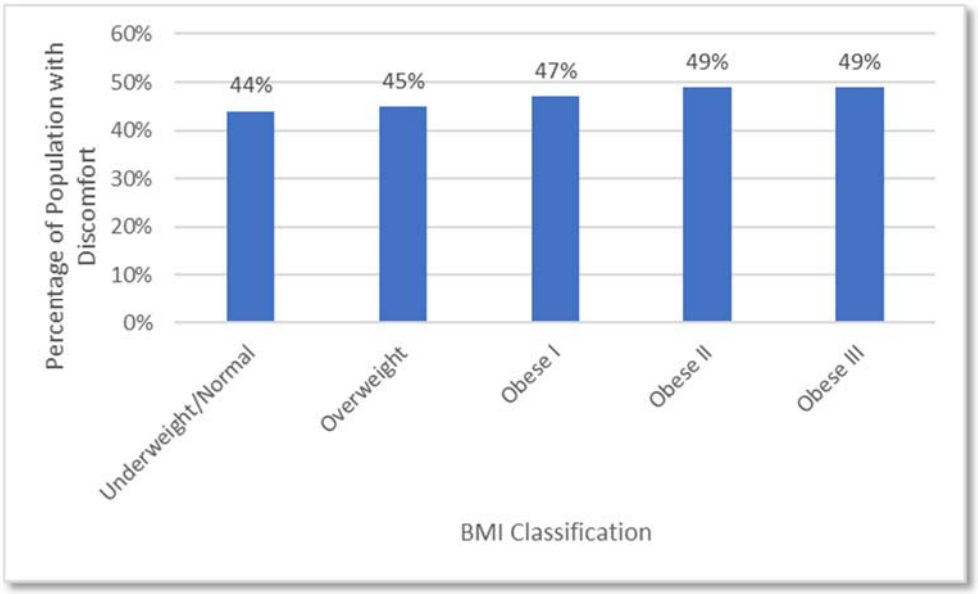


Figure 18: BMI Classification vs. Percent of Population with Discomfort

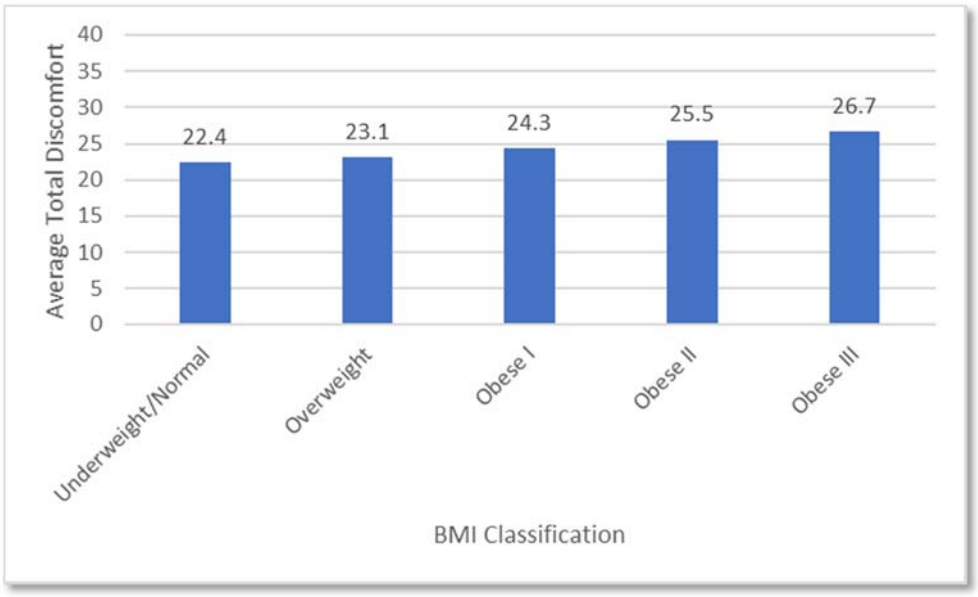


Figure 19: BMI Classification vs. Average Total Discomfort

When simplifying the groups into obese and non-obese categories, figure 20 demonstrates a 10% increase in average total discomfort.

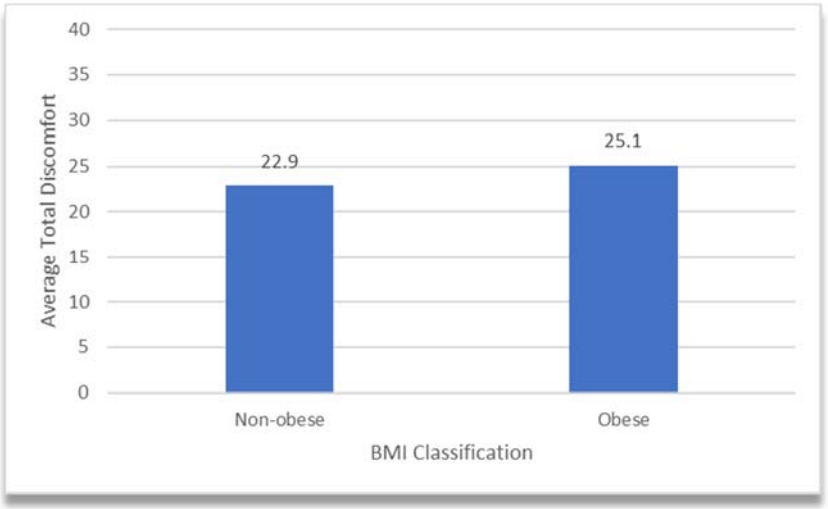


Figure 20: BMI Classification vs. Average Total Discomfort

Underweight/normal, overweight and obese I groups report the highest level of average regional discomfort within the head/neck, shoulders, and low back. Drivers in the obese II and III groups also report the highest level of average regional discomfort within the head/neck and low back. However, in comparison this group reports lower shoulder discomfort and higher knee discomfort.

Most notably, there is a significant increase seen in low back and knee discomfort as a driver's BMI increases. Figure 21 demonstrates the trend seen between BMI and knee discomfort (r=.98) and between BMI and low back discomfort (r=.95).

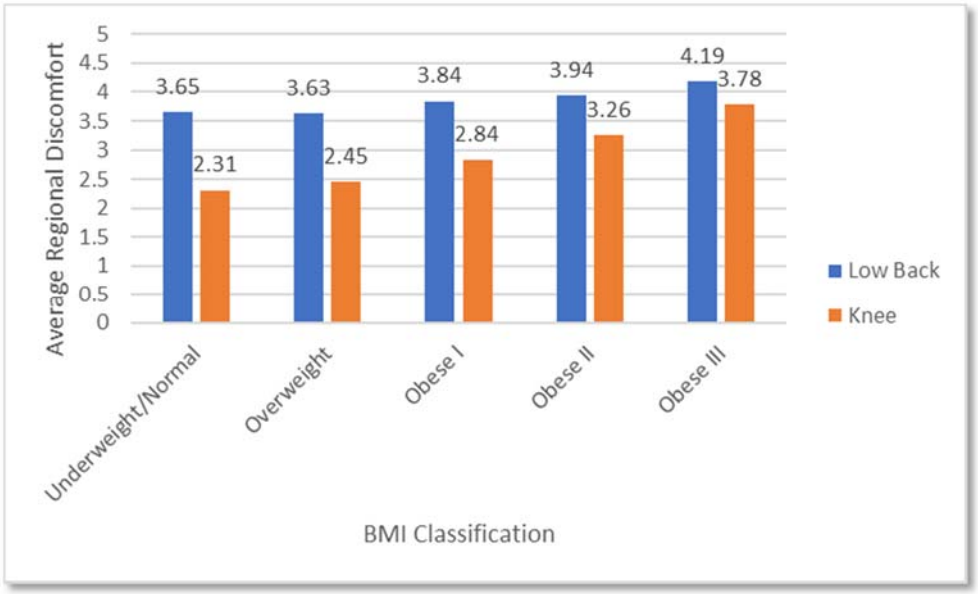


Figure 21: BMI Classification vs. Average Regional Discomfort

Effect of Material Handling

When comparing discomfort between drivers who handle freight and those who do not, it is surprising to find there is minimal impact on the driver's discomfort. Figure 22 demonstrates that there is no significant link between material handling and the prevalence of discomfort. In fact, all categories except obese III show a slight decrease in prevalence of discomfort. However, the difference in each category is insignificant.

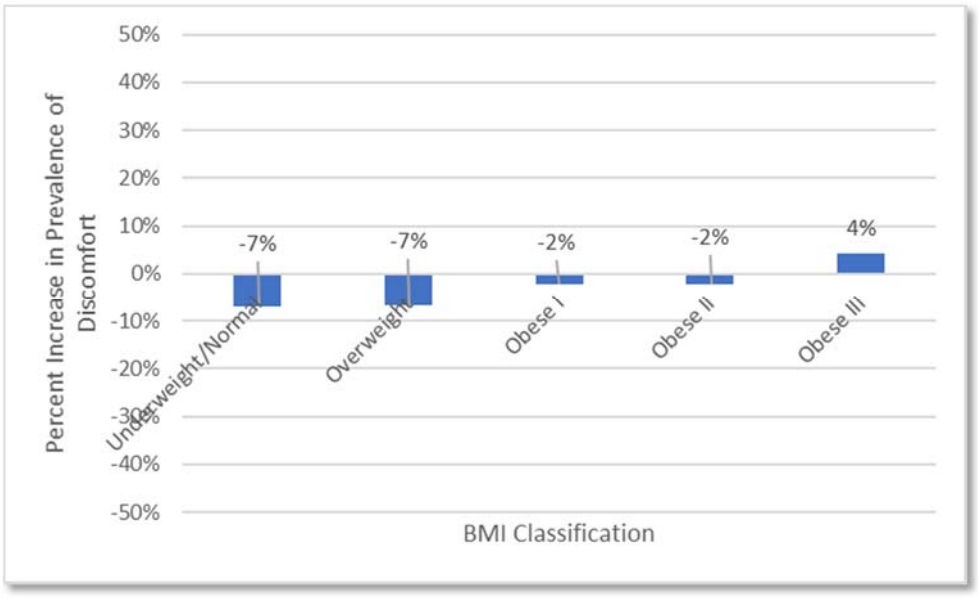


Figure 22: BMI Classification vs. Percent Increase in Prevalence of Discomfort for Material Handlers

There is also no significant trend seen in the average total or regional discomfort. Figure 23 demonstrates that the increase in total discomfort increases on average of 11.2% across the BMI categories. In fact, there is moderate correlation seen with drivers having lower BMI and higher average total discomfort (*r*=.55). The reasoning for this is unclear, but one possible explanation is that the overall higher level of total discomfort reported by obese drivers could mask the impact of material handling.

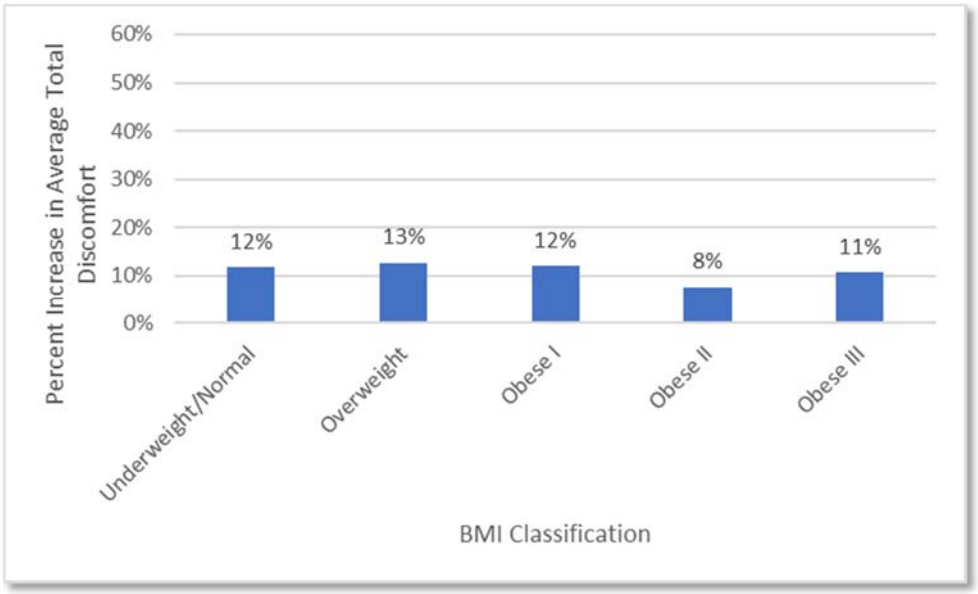


Figure 23: BMI Classification vs. Percent Increase in Average Total Discomfort for Material Handlers

Figure 24 looks at the average regional discomfort for drivers' knees and low back. These two categories demonstrated the most difference between drivers who performed material handling and those who did not. Although there is an increase in knee pain in general with employees who are handling freight, there is no correlation between increasing BMI and increased knee discomfort with material handling (r=.09). However, there is a strong correlation between increased low back discomfort and employees with lower BMI who are material handling (r=.91).

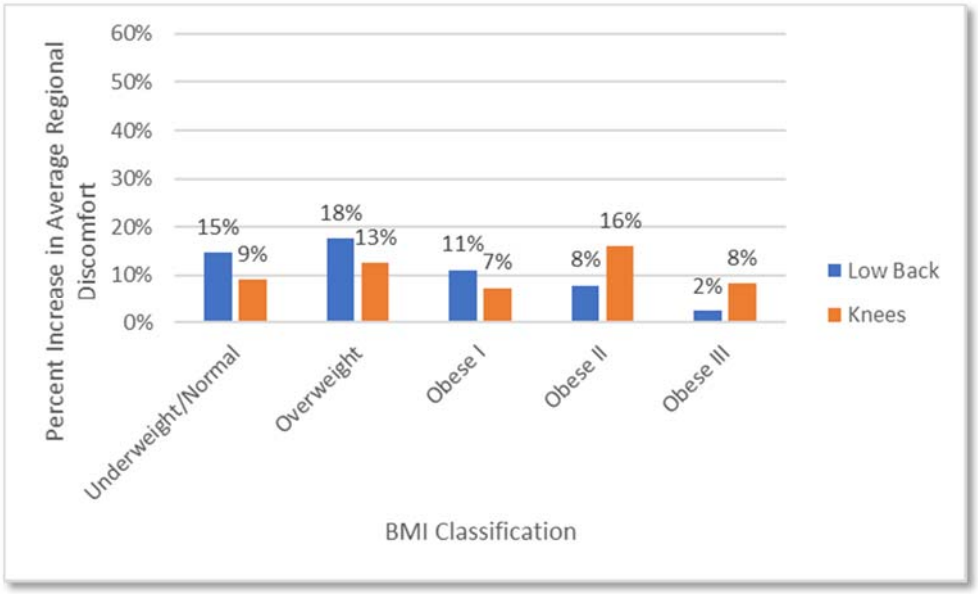


Figure 24: BMI Classification vs. Percent Increase in Average Regional Discomfort for Material Handlers

IMPACT ON APPROACH

Continue/expand health and safety programs for obese drivers to address discomfort and potential safety concerns. Prevention efforts should prioritize the knee, low back, and head/neck, but also include the total body. Fleets should also consider the impact of an ongoing wellness program given the overall higher incidence of obesity in the driver population. Programming should focus on 1) exercise, given the limited facility resources, 2) the nutritional challenges of drivers and 3) a supported weight management program. Success in this arena has been linked to traditional safety metrics.

Age

Figure 25 demonstrates the prevalence of discomfort in each age group. For clarification purposes, the 70+ yrs. group was not used in the analysis since less than 1% of the population fall in this age range and we would not be able to make any comparisons with confidence. In the remaining 5 groups there is a gradual increase in prevalence of discomfort seen as the employee ages (*r*=.98). The increase in the total average discomfort also follows an increasing trend as the employee's age increases (figure 26). However, this trend is not as strong (*r*=.58), and the highest average discomfort is seen in employees between the ages of 50-59 yrs.

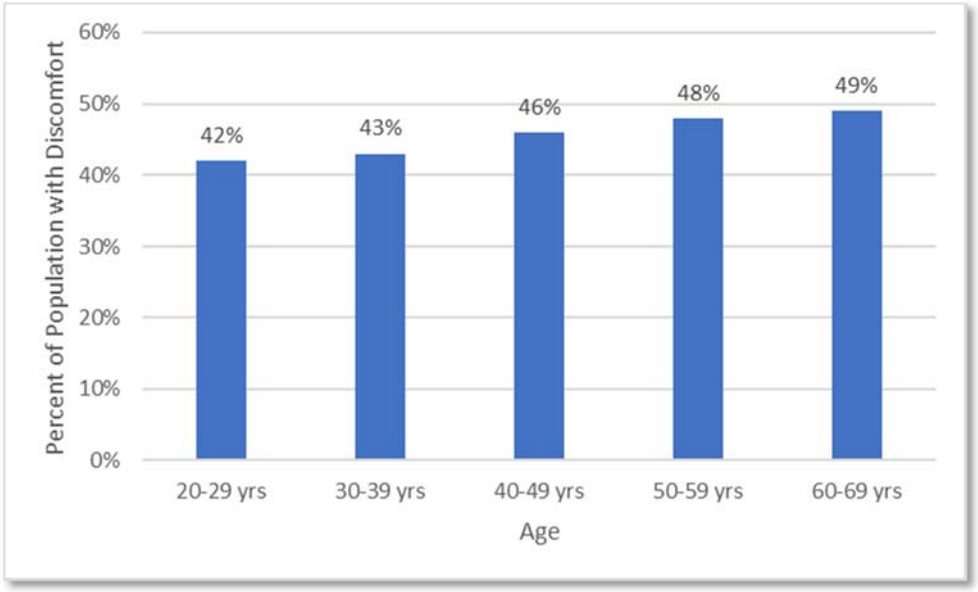


Figure 25: Percent of Population with Discomfort vs. Age

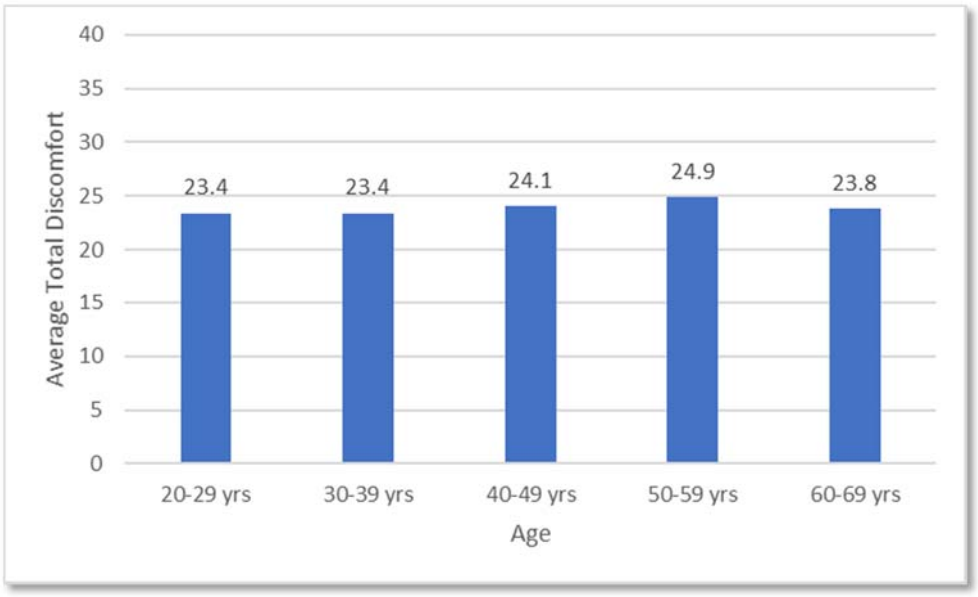


Figure 26: Average Total Discomfort vs. Age

When the discomfort is divided up into regions of the body, we see the same pattern throughout the age groups. The highest three regions are low back, head/neck and shoulder. Figure 27 demonstrates the differences within these three body regions per age group. Head/neck and shoulder discomfort both demonstrate an increasing trend as the age increases (*r=.83 and .92* respectively*).* However, the low back discomfort moves in the opposite and there is a negative correlation with age (*r*=-.97). Interestingly, average low back discomfort is highest in the younger groups and decreases as the employees' age increases. As age increases, employee's discomfort tends to be more consistent throughout the regions of the body. The younger employees tend to report higher average low back discomfort than any other region.

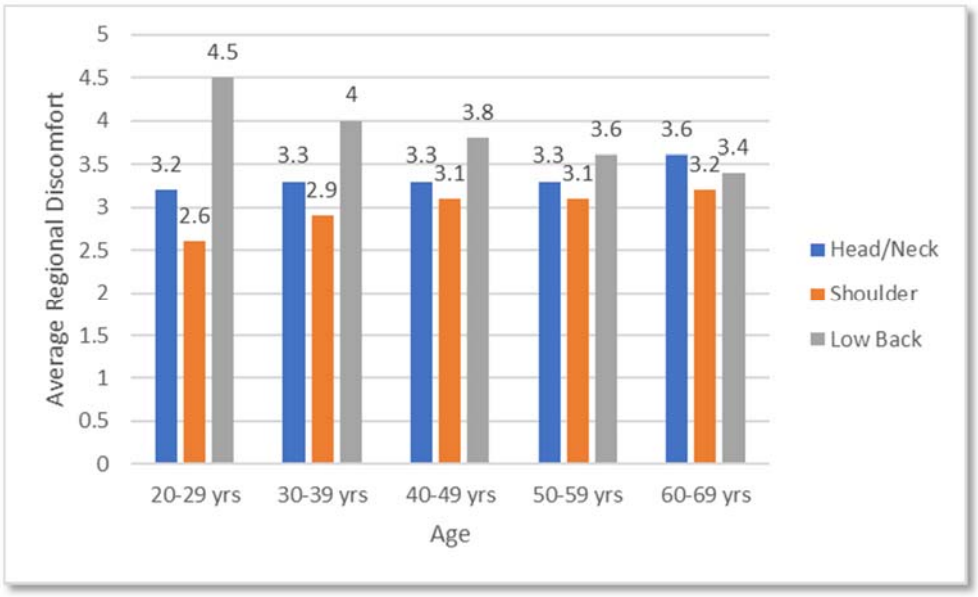


Figure 27: Average Regional Discomfort vs. Age

There was one region that older employees reported a more significant level of discomfort than younger employees, that being eye strain. Figure 28 demonstrates this trend and shows a 42% increase from employees in their 20s and 30s to employees in their 50s and 60s. This change most likely is due to the aging process but should be kept in consideration when looking at injury rates and prevention.

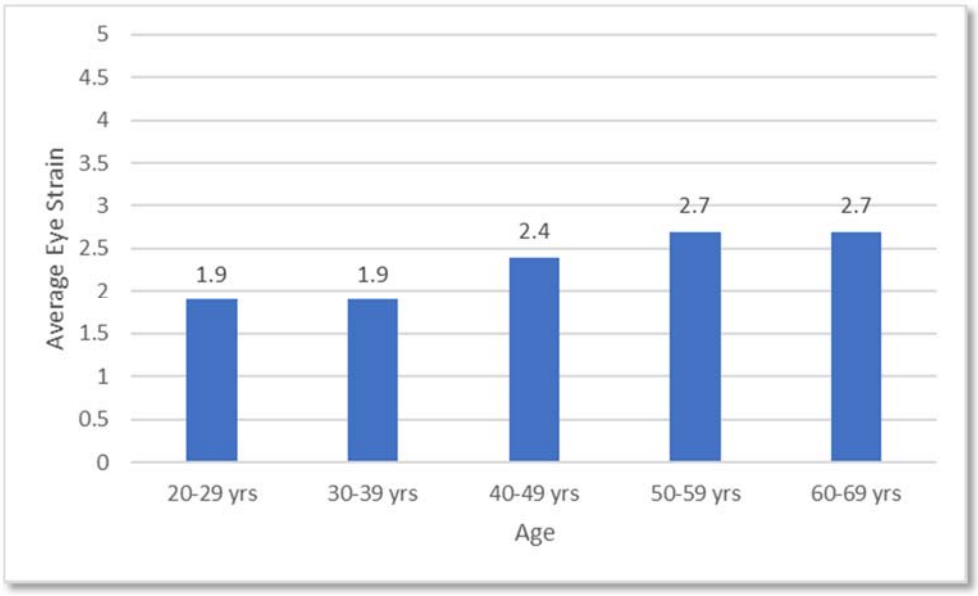


Figure 28: Average Eye Strain vs. Age

Effect of Material Handling

When comparing the prevalence of discomfort between drivers who handle freight and those who do not, there is no effect until drivers enter their 40s. Figure 29 demonstrates no change for the two younger groups, but an increase in the groups 40 yrs. and older (*r*=.94)

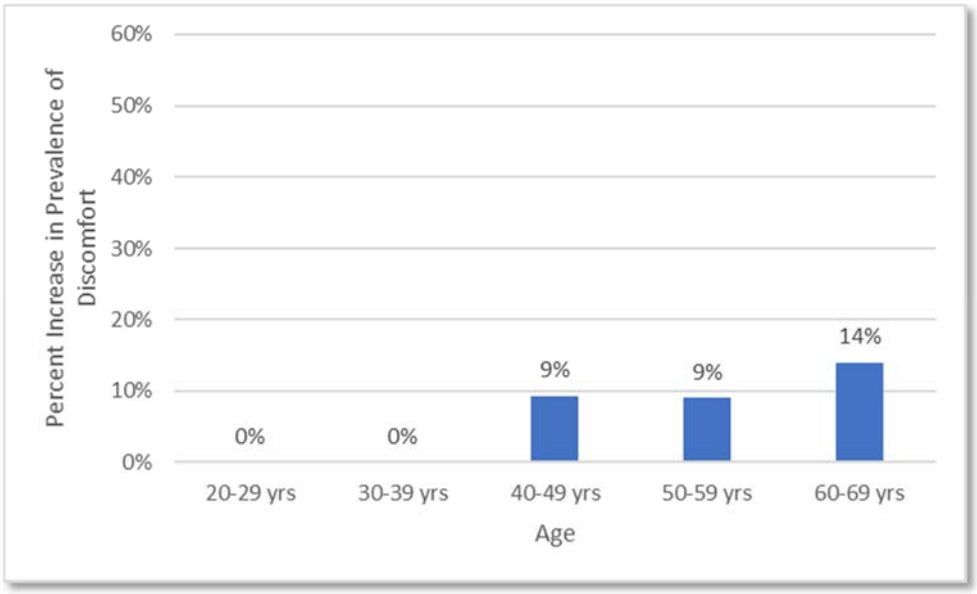


Figure 29: Percent Increase in Prevalence of Discomfort vs. Age for Material Handlers

On the other hand, increase in total discomfort is almost exclusively seen in the youngest of the population. Figure 30 demonstrates a 22% increase in average total discomfort for employees in their 20s and no significant difference in the other groups. Figure 31 also demonstrates that employees in their 20s have the highest increase in both shoulder and low back discomfort when handling freight.

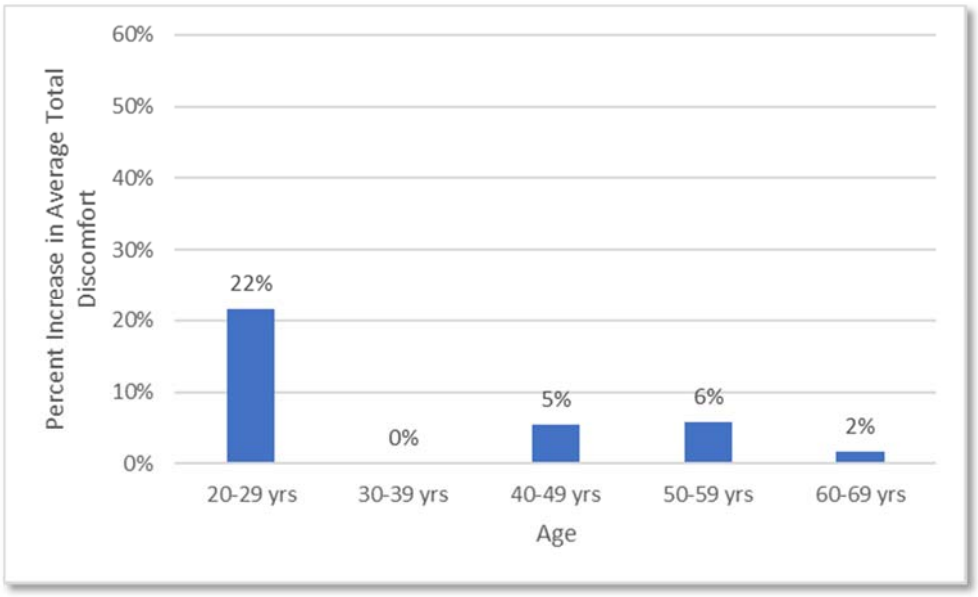


Figure 30: Percent Increase in Average Total Discomfort vs. Age for Material Handlers

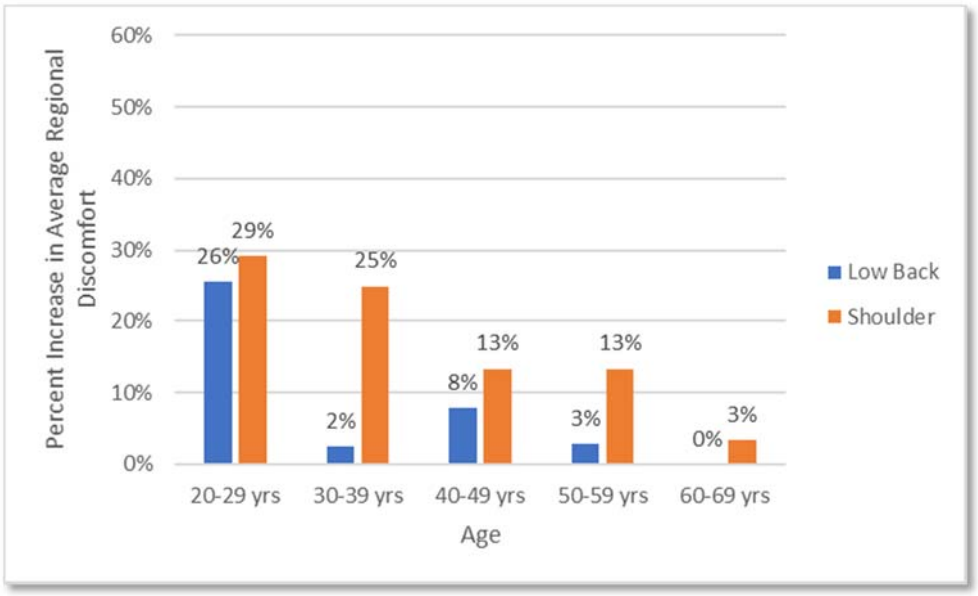


Figure 31: Percent Increase in Average Regional Discomfort vs. Age for Material Handlers

IMPACT ON APPROACH

There is an increase in overall prevalence of discomfort for drivers as they age. Educational material and modification programs should include information on the effect aging has on health and level of discomfort. Employees over 40 should be targeted for education on proper material handling as the prevalence of discomfort increases at this time of their tenure.

Regardless of age, if material handling is a consistent part of the job, targeted programming to reinforce good work habits is recommended.

Finally, given the higher average total and regional discomfort in the younger age categories, education on self-care, injury prevention and activity modifications is also recommended.

Gender

When considering gender and its effect as a demographic category on discomfort, it is necessary to look at the whether it is the gender itself or the physical differences between the genders that influences discomfort. If we compare males and females in the other three categories discussed in this paper, we find the following:

- Average height: Males: 5'10" Females 5'5"
- Average BMI: Males: 31 Females 32
- Average age: Males: 46 yrs. Females 45 yrs.

As seen above, height is the only significant gender driven demographic difference. Therefore while we will analyze gender it is important to always consider the broader impact of employee height.

Figure 32 demonstrates only a 7% increase in the prevalence of discomfort in females over males which is not significant. However, figure 33 demonstrates a 14% higher average total discomfort in females.

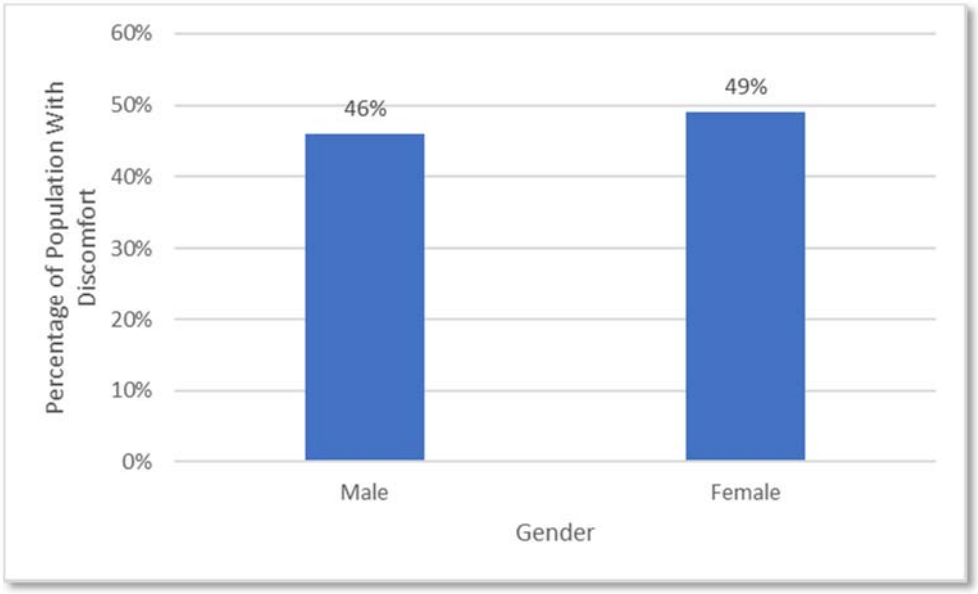


Figure 32: Percent of Population with Discomfort vs. Gender

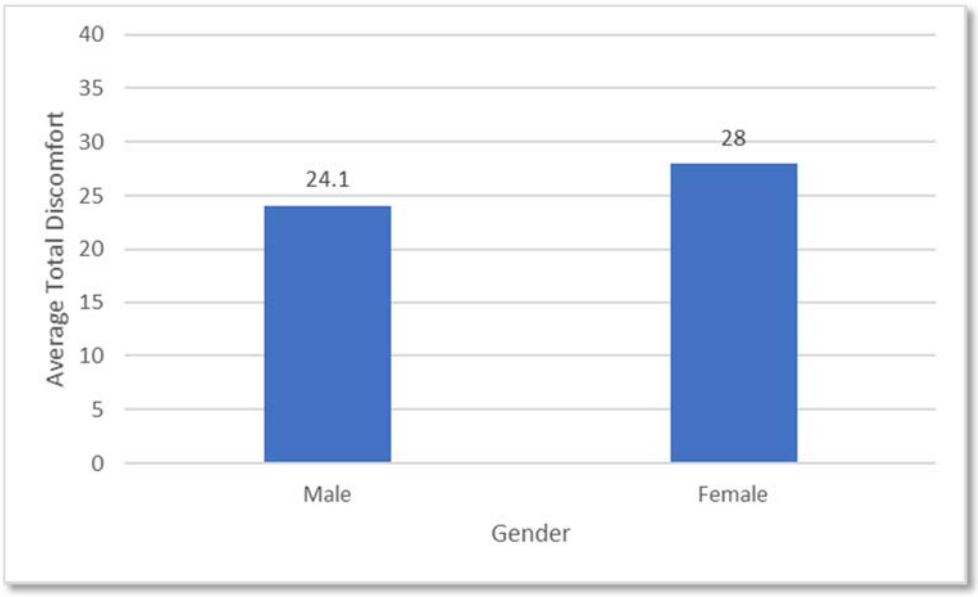


Figure 33: Average Total Discomfort vs. Gender

As was seen in the general population, both males and females have the highest regional discomfort in their low back, head/neck and shoulders. Figure 34 demonstrates shoulder discomfort is 40% higher and head/neck discomfort is 19% higher in female drivers than males. Low back pain is statistically similar but it is important to note that it provides the highest level of discomfort in both males and females.

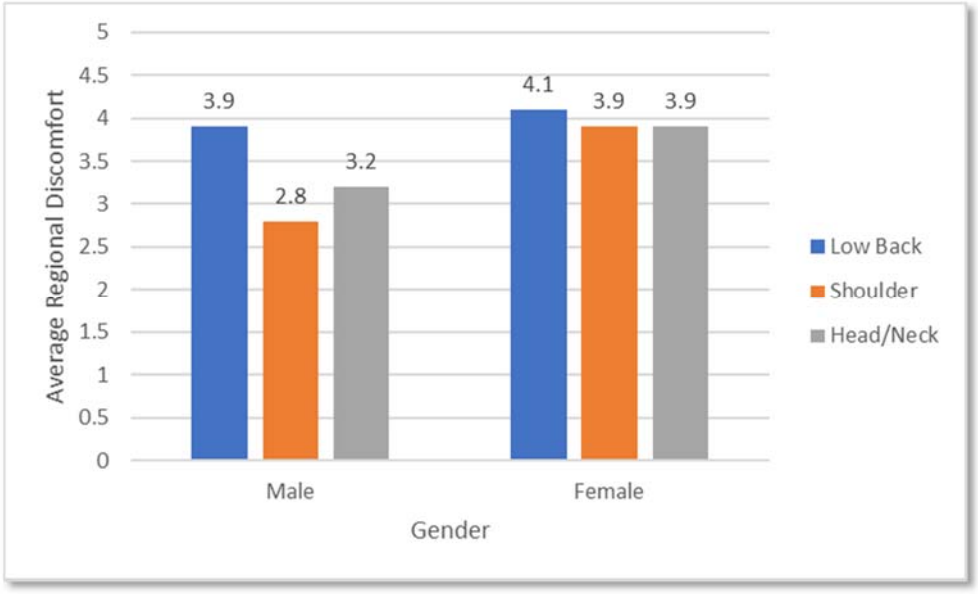


Figure 34: Average Regional Discomfort vs. Gender

Effect of Material Handling

When comparing the prevalence of discomfort between drivers who handle freight and those who do not, figure 35 demonstrates there is no difference in prevalence of discomfort between males and females. Both groups show an insignificant decrease in discomfort similar to that exhibited by the overall population.

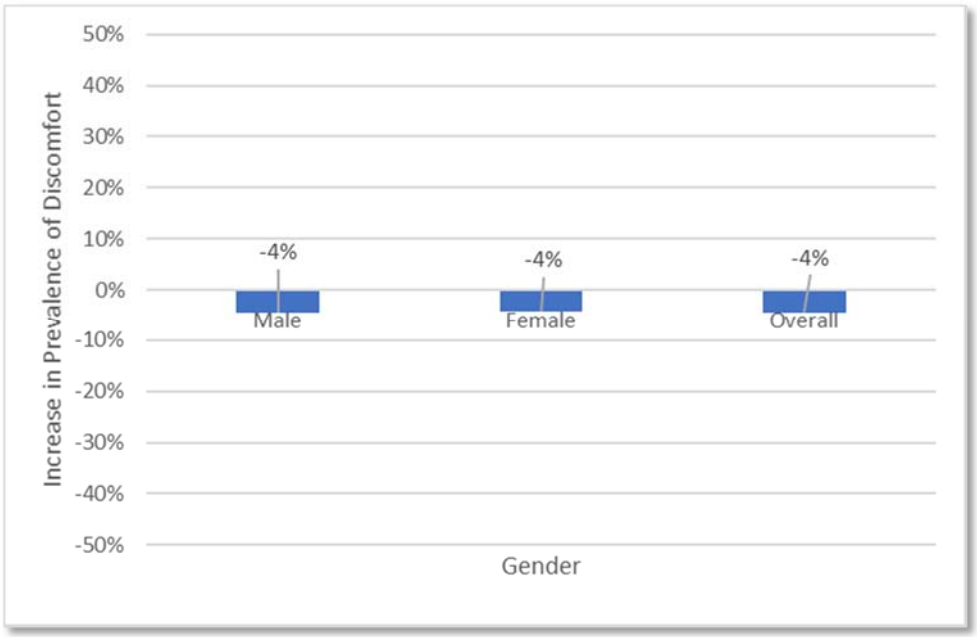


Figure 35: Percent Increase in Prevalence of Discomfort vs. Gender for Material Handlers

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Figure 36 demonstrates the difference in average total discomfort between the genders. Females demonstrate a 62% increase in total discomfort than males. When considering regions of discomfort, Figure 37 demonstrates that males have a 22% increase in shoulder discomfort, 3.4x the increase in females, and an 8% increase in low back pain, which remained consistent with females, when material handling is involved.

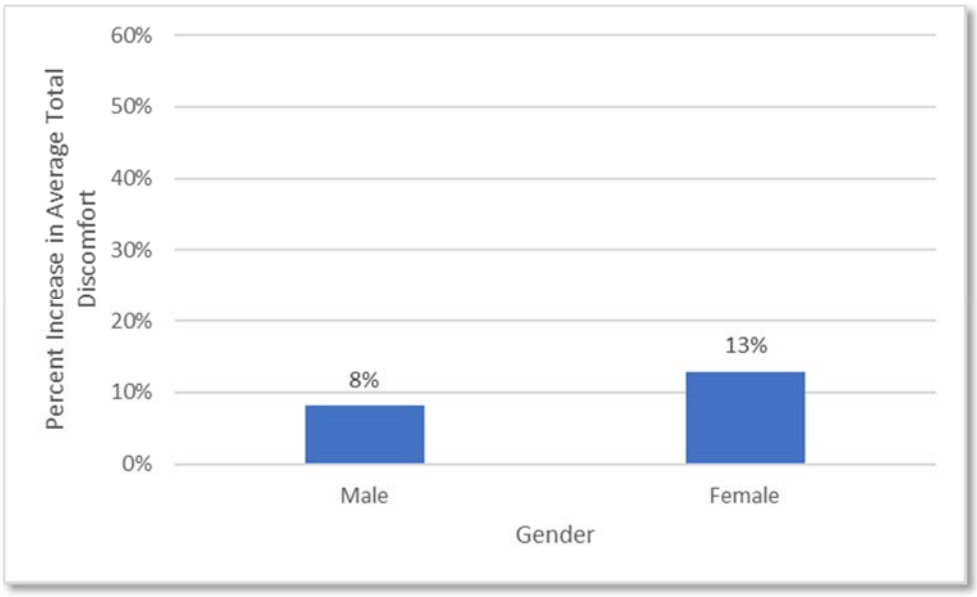

Figure 36: Percent Increase in Average Total Discomfort vs. Gender for Material Handlers

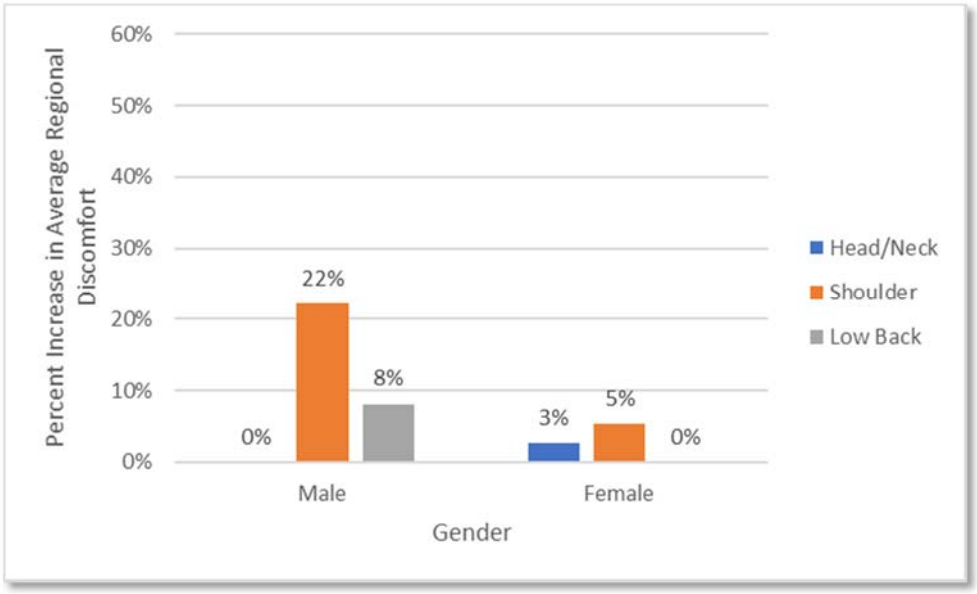

Figure 37: Percent Increase in Average Regional Discomfort vs. Gender for Material Handlers

IMPACT ON APPROACH

When considering gender as a demographic category to drive prevention and safety programs, one should first consider the other characteristics. Demographic categories of height, BMI, and age should be prioritized.

CONCLUSION

This is the first paper looking at discomfort trends within the transportation industry. Trends related to the demographic categories of height, BMI, age, and gender were analyzed through a 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.

- Height: *The need for emphasis on employees of shorter stature (i.e. <5'4") and taller employees (i.e. >6'3") should be prioritized. Emphasis should be placed on obtaining proper setup to allow a proper line of sight in both of these groups. Programs and solutions should promote proper support and cab setup to place less stress on taller employees' knees and decrease the need for reach with shorter statured employees.*

- BMI: *The analysis strongly supports the findings of a progressive increase in discomfort as an individual's BMI increases. Although there is a significant increase in the overall discomfort as an individual's BMI increases, special attention should be placed on the knee, low back, and head and neck for employees in any of the obese categories (BMI >30). Although there does not appear to be an increase in discomfort for obese drivers that perform material handling, this is most likely due to the underlying increase in discomfort that is found in obese individuals. Consideration of an ongoing wellness program is recommended to address exercise needs, along with the nutritional challenges of drivers.*

- Age: *The data analysis finds that increasing age is not necessarily a significant predictor of discomfort. However, there is an increased prevalence of discomfort as age increases, which is most noticeable with material handling. There should be emphasis on proper material handling for employees over 40 years old. Younger employees demonstrate a higher average total discomfort, as well as average regional discomfort, when material handling is involved. This is most evident in low back pain. This demonstrates that although they do not have discomfort as often as older employees, they report a higher severity of discomfort when it is present. Emphasis should be placed on ergonomic modifications and training for younger employees, targeting programs on reinforcing good work habits. Programs including education on self-care, injury prevention, and activity modifications is recommended*.

- Gender: *Although there is an increase in total discomfort seen with female participants, the data indicates this is due to employee height. On average female drivers are shorter in stature than their male counterparts. Emphasis should not be placed on employees due to gender but should focus on other demographic characteristics.*

The gathering of demographic data prior to completing an ergonomic assessment for drivers in the transportation industry is vital to understanding where emphasis needs to be placed. A survey similar to the one used by Atlas gives the employee the opportunity to provide this information before the evaluator begins the assessment. With this information, the evaluator is better equipped to provide a more effective assessment and better solutions.

The second paper in this series will further examine discomfort in the transportation industry with emphasis on material handling and other job demands.

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