An Atlas Injury Prevention Solutions White Paper

**November 2017**

# Office Ergonomics Trends Part I Update: Relationship between Employee Demographics and Discomfort


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## Contents



### Introduction

How well do we understand the link between the person and the onset of discomfort within an office environment? This is an update to our October 2008 white paper, using more recent data and increasing our study size from 2,441 to 26,469 employees.

### Overview & Data Collection

Data was collected from multiple office environments during a 9-year period between 2009 and 2017.

### Definitions

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

### Participants

There were 26,469 employees 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 and updated based on the new 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

In this update of our original three-part office ergonomics white paper series, Atlas Injury Prevention Solutions (Atlas) will revisit the relationship between employee demographics and reports of discomfort. In 2008, Atlas initially set out to define these relationships in a two-part process. First, a survey was distributed to approximately 80 safety, health, and ergonomics professionals to determine their opinions on some office ergonomics risk scenarios that are dealt with on a day-to-day basis. A portion of this survey looked at five demographic topics: height, weight, age, gender and work category. Table 1 describes the results of the survey.

**Table 1: Responses to Office Ergonomics Survey of Occupational Health Professionals**

| | Survey Questions | Yes |
|---|---|---|
| 1. | Do men experience higher levels of discomfort in the workplace? | 18% |
| 2. | As you get older, do you experience higher levels of work-related discomfort? | 82% |
| 3. | Is work category (job title) a reasonable method to distinguish risk in an office environment? | 51% |
| 4. | Is computing time (number of hours on computer per day) a good measure of risk? | 85% |
| 5. | Are tall people at a similar level of risk as short people (i.e. individuals at extreme ranges of height)? | 77% |

Secondly, an analysis was completed using data from a population of 2,441 employees who had participated in the Atlas office ergonomics assessment process. The results were then compared to the responses from the survey as seen in Table 2.

**Table 2: Comparison of Survey Responses and Analysis Findings**

| | Survey Questions | Response | Findings |
|---|---|---|---|
| 1. | Do men experience higher levels of discomfort in the workplace? | No | No |
| 2. | As you get older, do you experience higher levels of work-related discomfort? | Yes | No |
| 3. | Is work category (job title) a reasonable method to distinguish risk in an office environment? | Yes | No |
| 4. | Is computing time (number of hours on computer per day) a good measure of risk? | Yes | Yes |
| 5. | Are tall people at a similar level of risk as short people (i.e. individuals at extreme ranges of height)? | Yes | No |

Table 2 demonstrates that the original paper found a discrepancy between the opinions/expectations of industry professionals and the objective data analyzed in three of the five areas. This paper will revisit the original findings through a more recent and larger data set.

## OVERVIEW AND DATA COLLECTION

There are many concerns that arise when tasked with an ergonomic assessment of an individual's office. As we found in the original paper, many times our expectations can be flawed and mislead us from the important aspects of the evaluation. Consideration must be placed on the characteristics of the worker (demographics), type of work, the work station setup (available equipment/accessories), and what trends are seen in the current research available to us. This paper will examine the relationship between demographics and discomfort, compare our findings to current research, and discuss how those findings should impact the approach taken during an office ergonomic assessment.

For this paper, data collection was completed using Atlas' web-based office ergonomics assessment software AtlasOffice™. Before an onsite assessment is completed, AtlasOffice™ generates an online survey for the employee to complete. This survey is used to supplement an onsite assessment by gathering data related to employee risk as one of the first steps in the process. Each question within the survey was designed to assess different elements of office ergonomic risk and has been chosen based on current research and standards. Although this survey addresses both workplace conditions and employee demographics, this paper will only focus on how demographics impacts ergonomic risk in the office environment.

The survey begins by asking the employee to provide basic information to assist in defining their demographics. Figure 1 provides an example of one of the demographic survey pages, where information such as gender, age, height, and weight are collected.

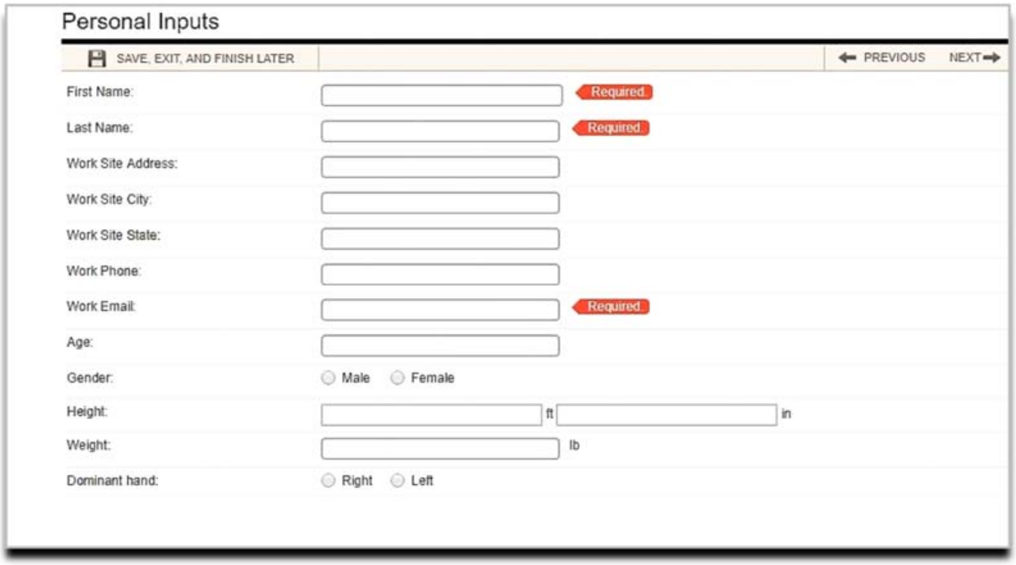



**Figure 1: Demographic Input Screen**

The next part of the survey consists of discomfort-related questions. The employee is asked if he/she is experiencing discomfort (Figure 2) and then is led to a screen to identify the location of the discomfort (Figures 3).

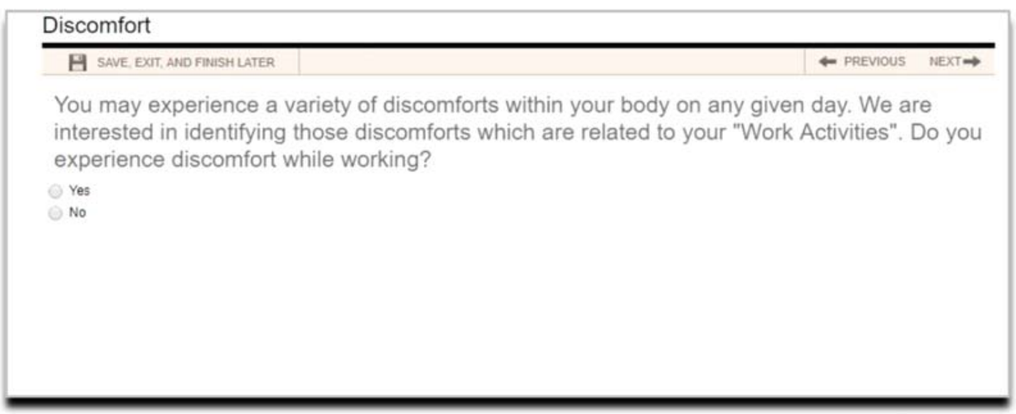



**Figure 2: Prevalence of Discomfort**

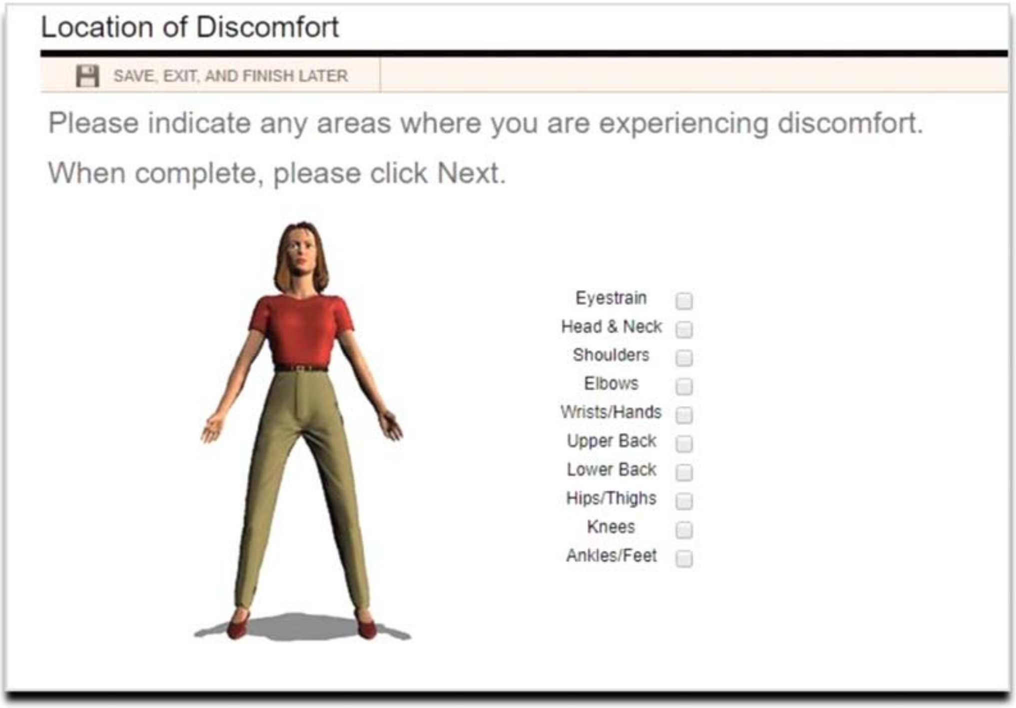



**Figure 3: Area of Discomfort**

Discomfort is then assessed in each area that the employee checked by using a health index. This uses a 5-point scale for frequency and severity of symptoms (Figure 4). The multiplicative value of these discomfort variables (F x S) is rated as low, moderate, high, and extreme.

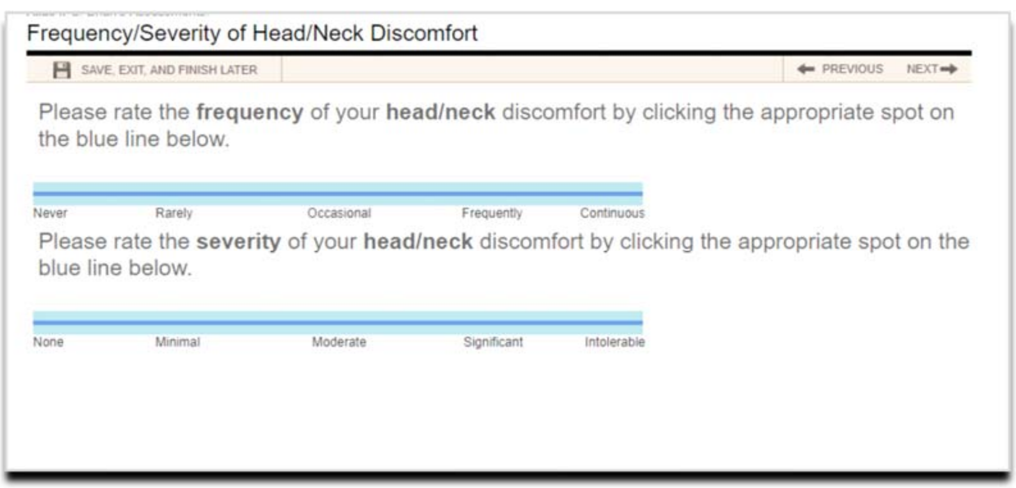



**Figure 4: Frequency and Severity of Discomfort**

The employee is then asked to rate their productivity loss. This uses a 5-point scale between 0 (None) and 4 (Continuous) to obtain a perceived loss of productivity due to their discomfort (Figure 5).

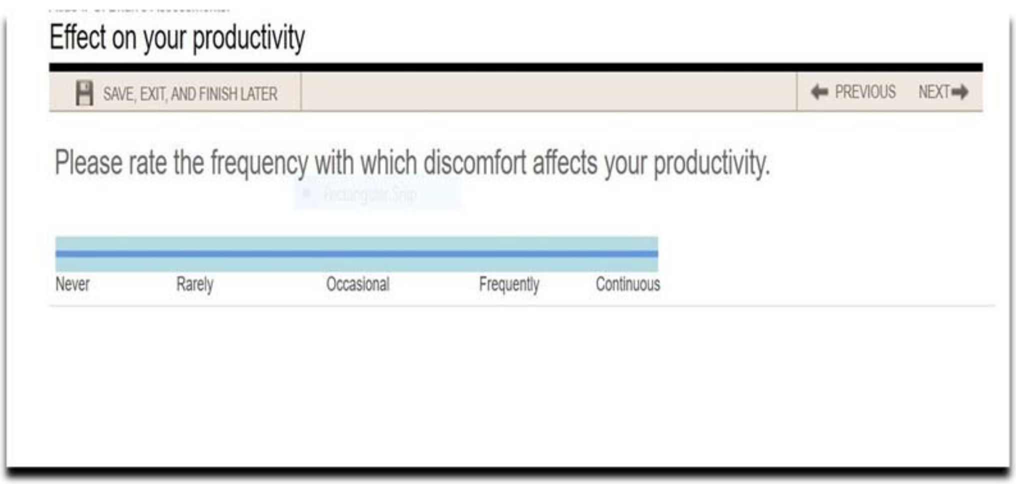
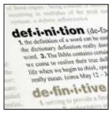



**Figure 5: Effect on Productivity**

The remaining questions within the survey then focus on work tasks and equipment/furniture availability and setup. Ergonomic risk is assessed by comparing questions related to personal and task variables (e.g. height, BMI, hours of work, etc.) to an audit of the products and features that are present in the office. Using a logic table, any gaps in product availability and workstation design are identified.

Once the data has been submitted by the employee, it is available to an analyst in a checklist format to review and help with preparation for the onsite evaluation. Additionally, raw data can be downloaded into a spreadsheet for analysis and review.



## DEFINITIONS

In order to compare demographic variables to discomfort, it was necessary to process the discomfort data and present it in formats that aided in viewing the potential relationships. Four key measures of discomfort were used to illustrate the interaction between demographics and discomfort:

**Discomfort Prevalence**: At the time of the survey an employee is asked whether they are experiencing discomfort related to work activities. This Yes/No question provides a measure of the percentage of employees that are experiencing 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 health index. This raw score provides a measure of the discomfort for a single body part.

**Total Discomfort**: Adding all health indices for a single employee (i.e. scores for all body parts) provides a measure of the total discomfort for the employee.

**Average Total Discomfort**: In order to compare differences between groups, an average of the total discomfort scores across all employees in the group must be calculated. For example, the average total discomfort for employees who are <5’1” is 33.01.

**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 26,469 employees who completed an AtlasOffice™ online survey. These employees were from a subset of clients served by Atlas over the 9-year period (2009-2017). These companies come from a number of economic sectors, including aerospace, automotive, chemicals, consumer goods, healthcare, insurance, oil and gas, pharmaceutical, technology, and utilities. All employees were employed in an office position in either a traditional office setting or a home office setting. The figures below give a breakdown of the participants' demographic data

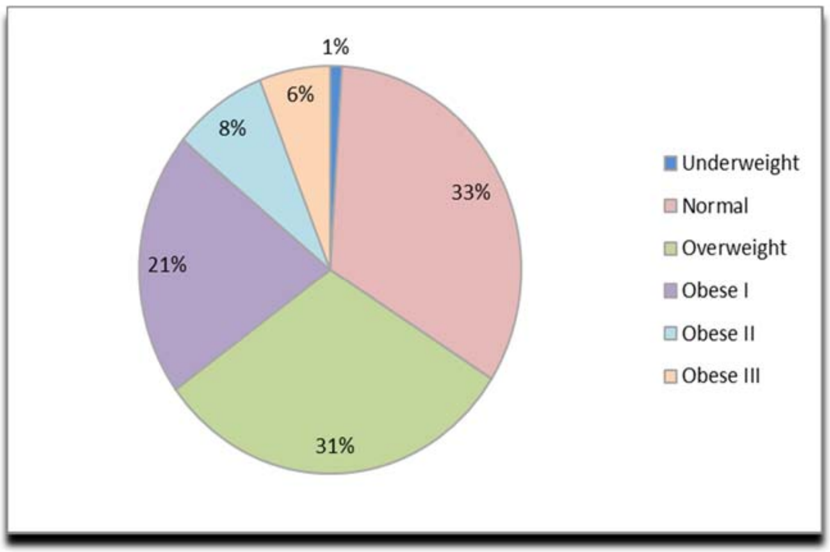



**Figure 6: BMI Distribution**

Figure 6 presents the breakdown of the study population based on body mass index (BMI). This data demonstrates a similar incidence of an obese and overweight population in comparison with the information collected by the Center for Disease Control (CDC) on the population by BMI classifications[1]. The CDC found an incidence of obesity in the US at 37.9% as compared to the study's finding of 35%. Also, the CDC found 70.7% of people either overweight or obese in comparison to the study's finding of 66%.

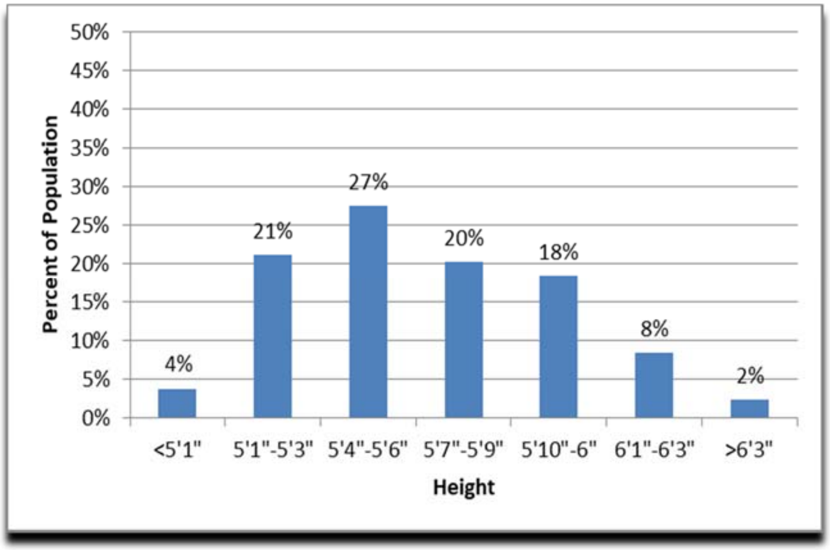



**Figure 7: Height Distribution**

Figure 7 presents the breakdown of the study population based on height. The figure shows a slight skew in the data towards shorter height ranges, but it is not far from a normal distribution.

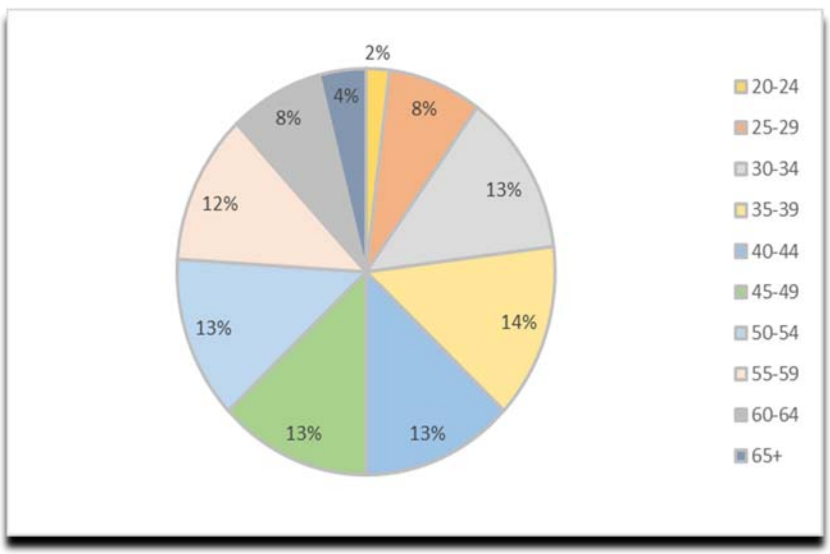



**Figure 8: Age Distribution**

Figure 8 presents the breakdown of the study population based on age.

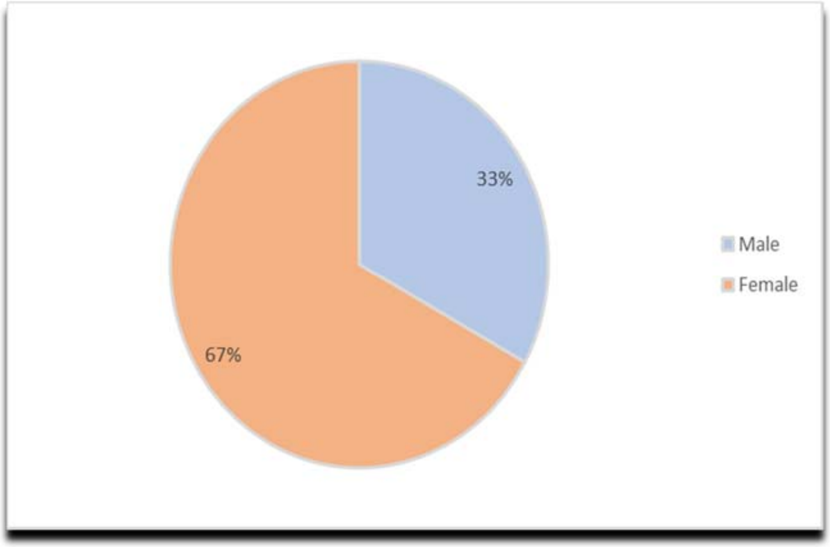



**Figure 9: Gender Distribution**

Figure 9 presents the breakdown of the study population based on gender. Women represent two-thirds of the total number of participants.

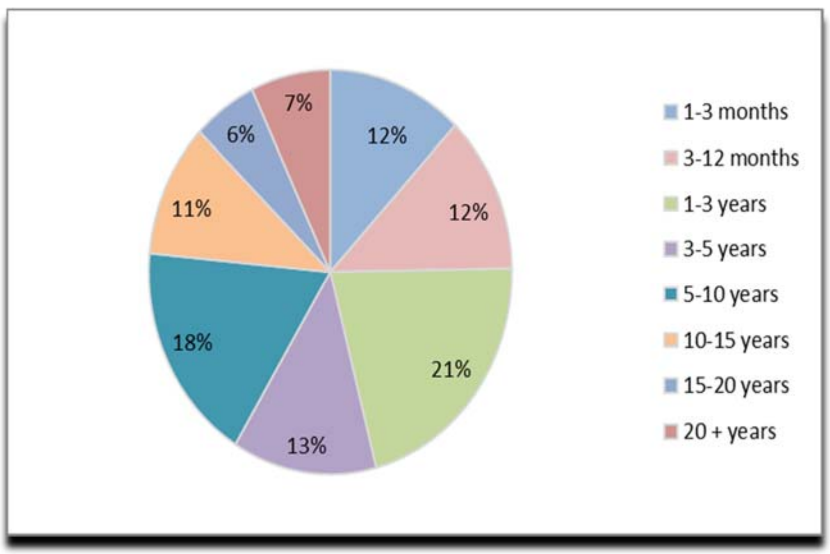



**Figure 10: Job Tenure Distribution**

As a new addition to the study, Figure 10 presents the breakdown of the time participants have worked in their current position (job tenure).

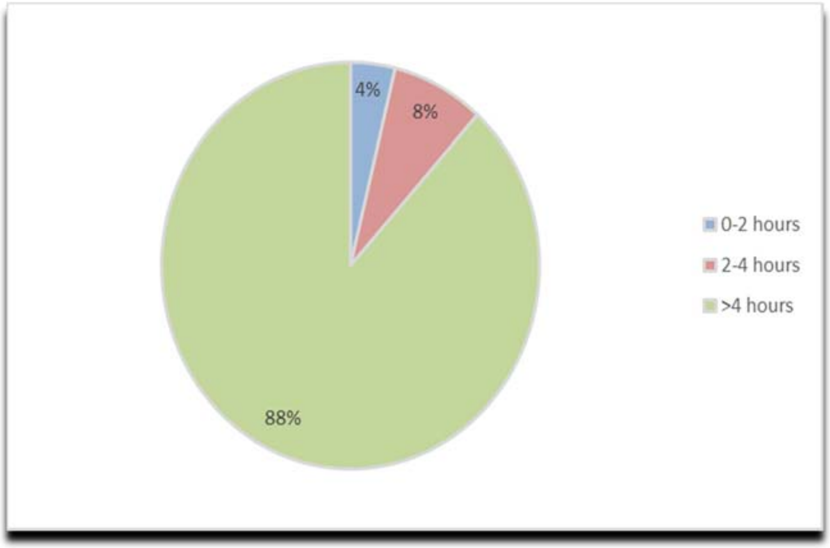



**Figure 11: Average Daily Computer Use**

The original paper found there was no significant impact on discomfort related to an employee's work category. This question was subsequently removed from the survey. Instead, the paper concluded the cause of discomfort was driven primarily by computer use. In support of this conclusion, Figure 11 demonstrates the breakdown of the amount of time employees spent on their computer daily. For the purposes of this study, computer use was separated into three categories: less than 2 hours, 2-4 hours and over 4 hours. As demonstrated above, 88% of the employees surveyed spent greater than 4 hours a day on the computer, which demonstrates the data set is representative of higher risk office workers.

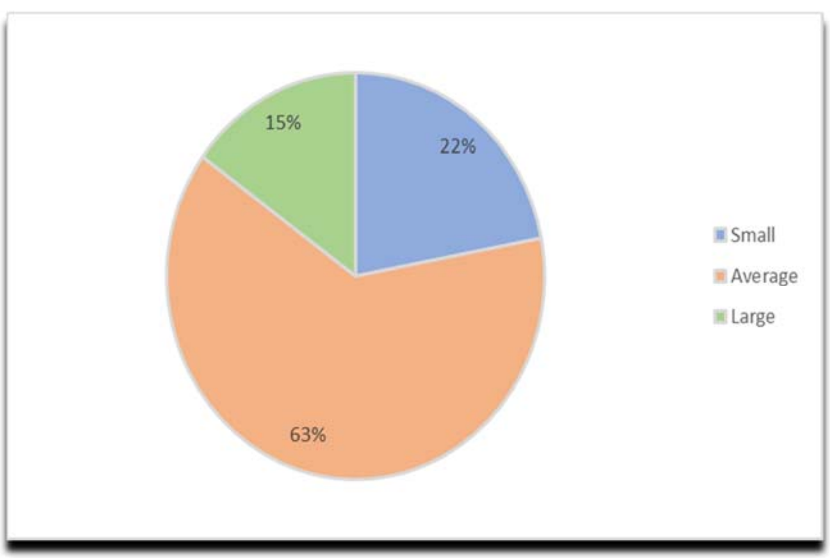



**Figure 12: Hand Size**

As a new addition to the study, Figure 12 demonstrates the distribution of the employee's reported hand size.

# DEMOGRAPHICS VS. DISCOMFORT

This update was tasked to review the findings of the original paper from 2008 and further investigate this topic with a larger and more recent data set.

## *BMI*

Similar to the 2008 report, there was a progressive increase in reported discomfort associated with an increase in BMI. Using normal BMI as a reference point, the increase in total discomfort ranged from 10% to 32% for obese workers (Figure 13). The location of discomfort associated with BMI was distinct (Figures 14-16). For example, the increase in discomfort at the knee was progressive, ranging from a 23% increase for overweight workers to a 112% increase for Obese Class II workers and a 531% increase for Obese Class III workers. Although low back and wrist/hand discomfort also showed progressive increase compared to normal BMI, the effects were lower compared to the knee.

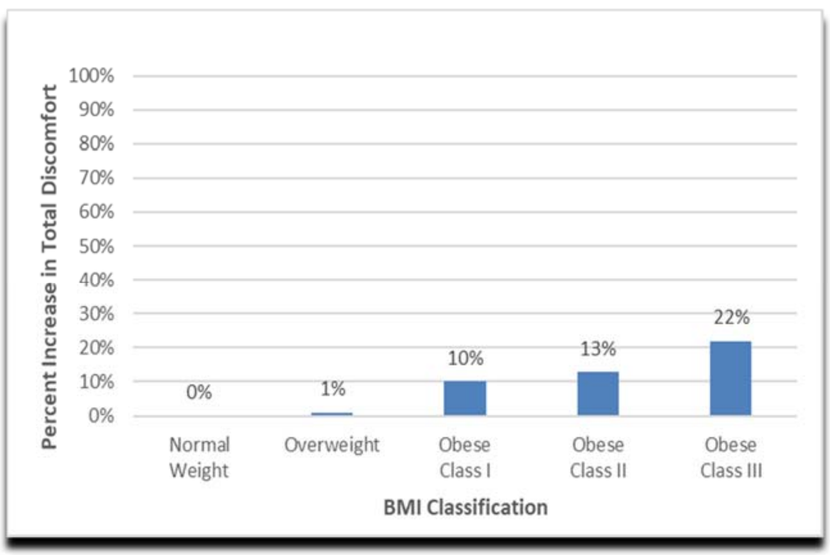



**Figure 13: BMI Classification vs. Total Discomfort**

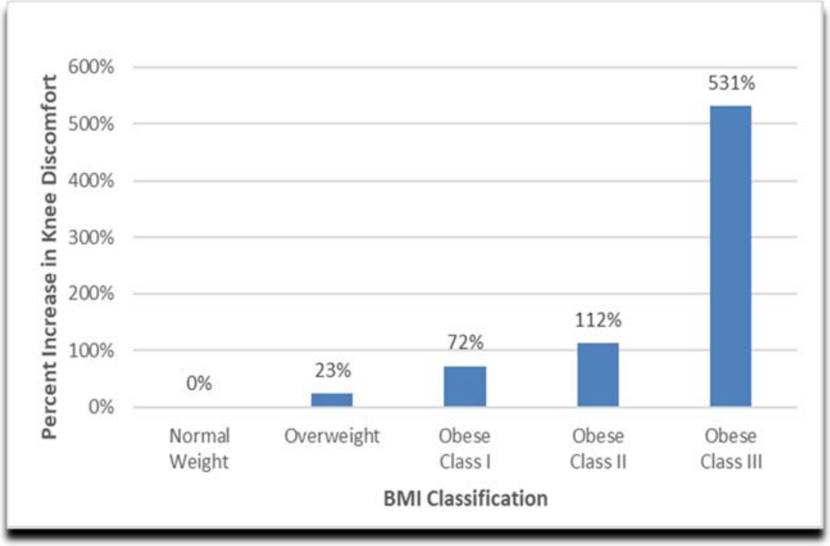



**Figure 14: BMI Classification vs. Knee Discomfort**

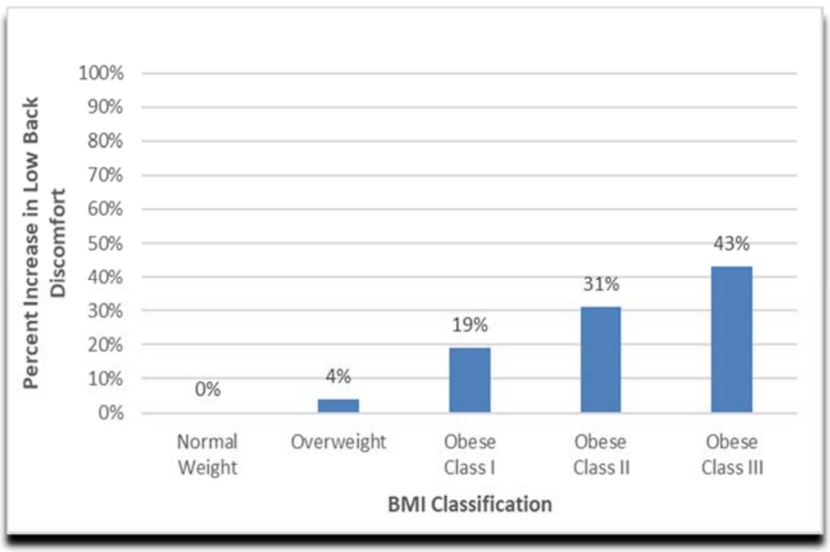



**Figure 15: BMI Classification vs. Low Back Discomfort**

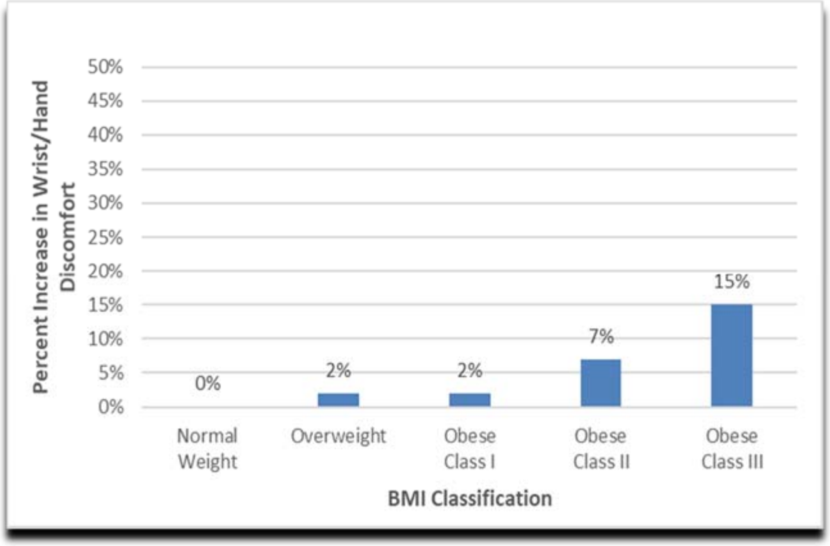



**Figure 16: BMI Classification vs. Wrist/Hand Discomfort**

## Effects of Obesity on Productivity

The first paper discussed cost of claim being higher across the higher classifications of obesity per Østbye et al in 2007. The Østbye study found significantly higher lost work days, as well as higher cost per claim in individuals in Obesity Class II and III[2]. With this study, we see a strong positive correlation between increasing BMIs and self-reported perceived productivity loss *(r=*.922). Figure 17 demonstrates the comparison of BMI and the percentage of individuals reporting continuous/frequent productivity loss. There is a significant increase in the report of continuous or frequent loss of productivity due to discomfort as the level of obesity increases, with 64% of people in Obesity Class III reporting the highest productivity loss.

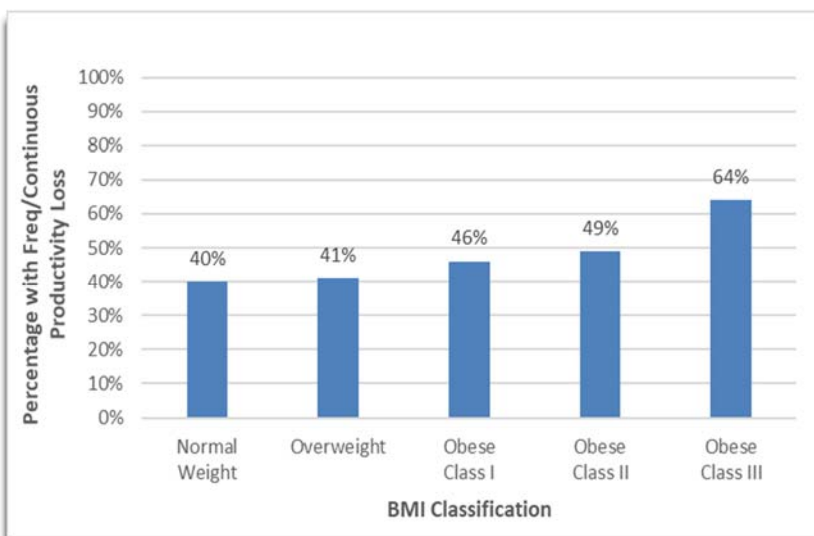



**Figure 17: BMI Classification vs. Frequent/Continuous Productivity Loss**

**Data Summary:**

***Influence of BMI on Discomfort and Productivity***

*Higher BMI is associated with progressively greater discomfort and productivity loss. At the highest obesity classification (Obese Class III), the levels of discomfort and productivity loss compared to normal BMI are striking and localized by body region. For example, Obese Class III individuals are characterized by 32 % greater total body discomfort, 531% greater knee discomfort, 43% greater low back discomfort, and 15% greater wrist/hand discomfort. Productivity loss reaches 64% for the same Obese Class III workers. The association of BMI, discomfort, and productivity loss is significant and progressive across BMI classifications.*

***Comparison to published data***

This data agrees with published reports supporting the influence of BMI on employee health and costs with Obese Class II and III workers. Van Nuys et al found that normal BMI employees cost, on average, $3,830 per year in covered medical, sick day, short-term disability, and workers' compensation claims combined; obese employees cost more than twice that amount, or $8,067. Obese employees also require longer recovery time and extended time away from work in comparison to normal BMI employees[3].

There are also many comorbidities associated with obesity that can have a major effect on discomfort. Diabetes, osteoarthritis, depression and sleep apnea [3] can all play a role in an individual's comfort, as well as ability to recover from repetitive and sustained activity.

***Impact on Approach:***

**Continue/expand ergonomic programs for Obese Class II and III workers to address discomfort and potential productivity loss. Because the increase in wrist/hand discomfort is low, prevention efforts might prioritize the knee, low back, total body and then wrist/hand to maximize benefits. Part II of the white paper series on *Office Ergonomics Trends*, as well as the case study presented in a previous Atlas white paper*, Addressing the Challenge of Obesity and Ergonomics in the Office Environment,* discusses the concerns of the population and provides additional input into choosing the right furniture for obese employees**.

***Height***

The findings on height in the original paper were that employees of shorter stature, especially under 5'1'', have a higher prevalence of discomfort, and that most products and furniture available in office settings do not address their needs. There continues to be a clear relationship between shorter stature and increased discomfort. As the individual regions of the body are examined, individuals with shorter stature demonstrate increases in average discomfort in the low back, neck and upper back (Figures 18-21).

Taller individuals did not have the same findings. There was no significant difference for individuals over 5’4” in average discomfort for any specific region of the body except for low back pain. Individuals over 6’3” had a significant increase in low back pain.

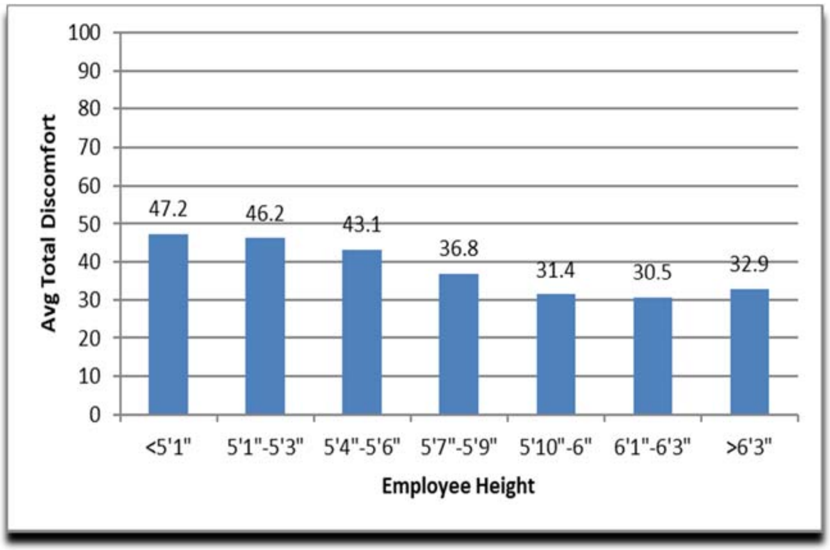



**Figure 18: Height vs. Average Total Discomfort**

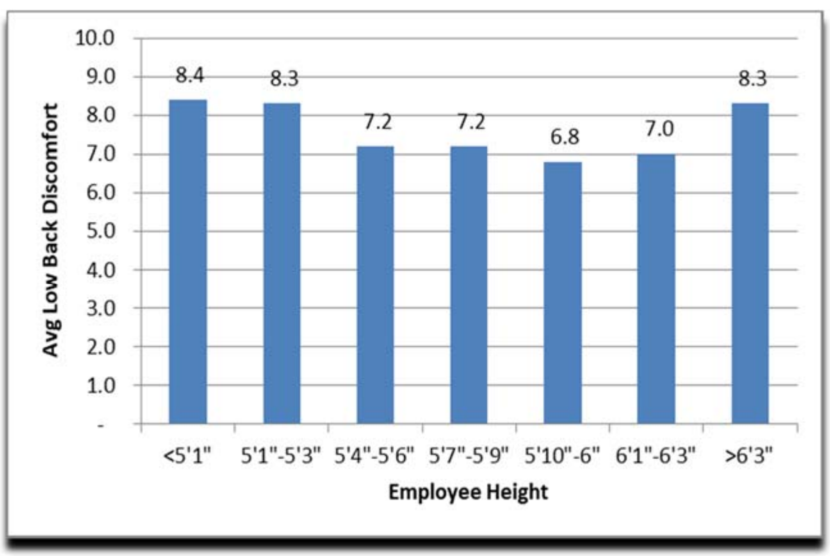



**Figure 19: Height vs. Average Low Back Discomfort**

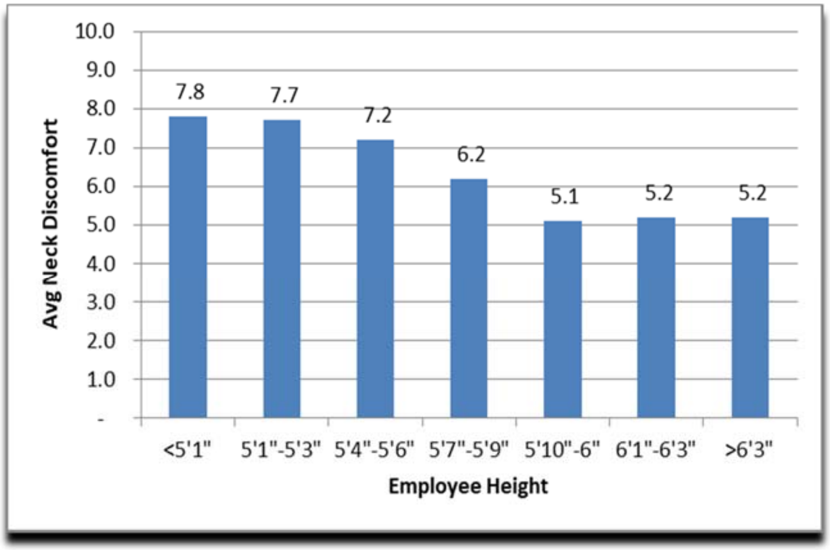



**Figure 20: Height vs. Average Neck Discomfort**

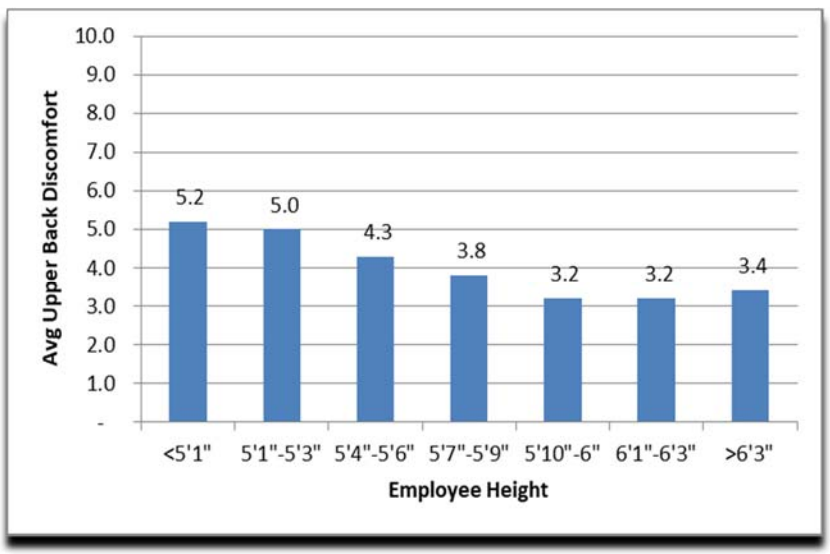



**Figure 21: Height vs. Average Upper Back Discomfort**

## Effects of Height on Productivity

Similar to the increase in discomfort exhibited in employees with shorter stature, there is also a decrease in productivity (Figure 22). There is a strong negative relationship (r=-.90) between height and productivity loss. This is seen with employees under 5’1” having the highest report of productivity loss (41%). Overall, employees 5’6” and under report higher productivity loss compared with their taller counterparts.

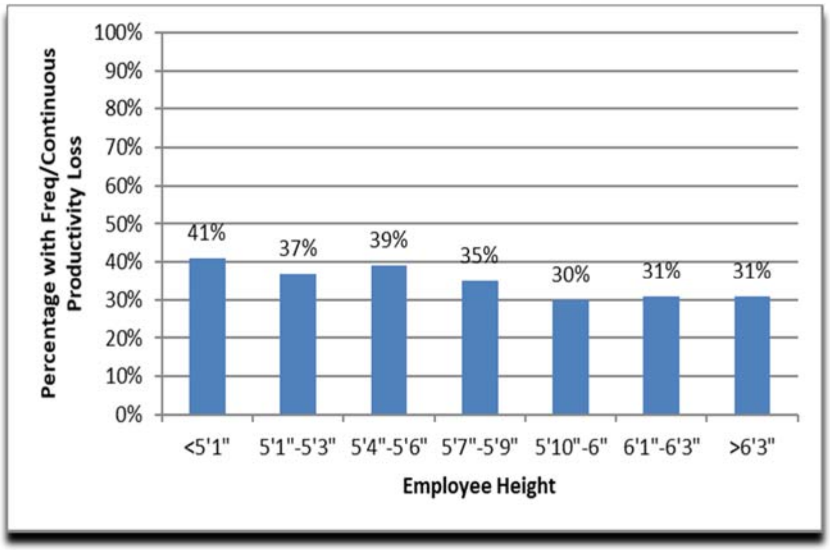



**Figure 22: Height vs. Percentage with Freq/Continuous Productivity Loss**

**Data Summary:**

***Influence of Height on Discomfort and Productivity***
*Shorter stature is associated with progressively greater discomfort and productivity loss. Individuals under 5'3" have the highest overall levels of discomfort, and those 5'6" and under have the highest levels of productivity loss compared to taller employees.*

***Comparison to published data***
Upon review of the current research in office ergonomic trends, there is not sufficient data on the role height has on discomfort or productivity.

***Impact on Approach:***
**Emphasis should be placed on ergonomic modifications for individuals 5'3" and under, as well as those over 6'3" tall with low back pain. Special attention should be placed to allow proper spinal alignment to decrease the stress on the low back, neck and upper back. Employees in these two categories demonstrate a more challenging time adapting to their work station. Specialized chairs, furniture and equipment should be considered to allow proper spinal support including lumbar support and allowing their feet to rest fully supported.**

***Age***

The findings on age in the original paper were that although the youngest age group of employees (20-24 yrs) had the highest level of discomfort, age is not a great predictor of discomfort in the office setting. Further analysis of the current data finds that age continues to be a poor predictor of discomfort with no significant difference between age groups. Figure 23 depicts the average discomfort for each age group, demonstrating no clear relationship between age and discomfort (*r*= -0.13).

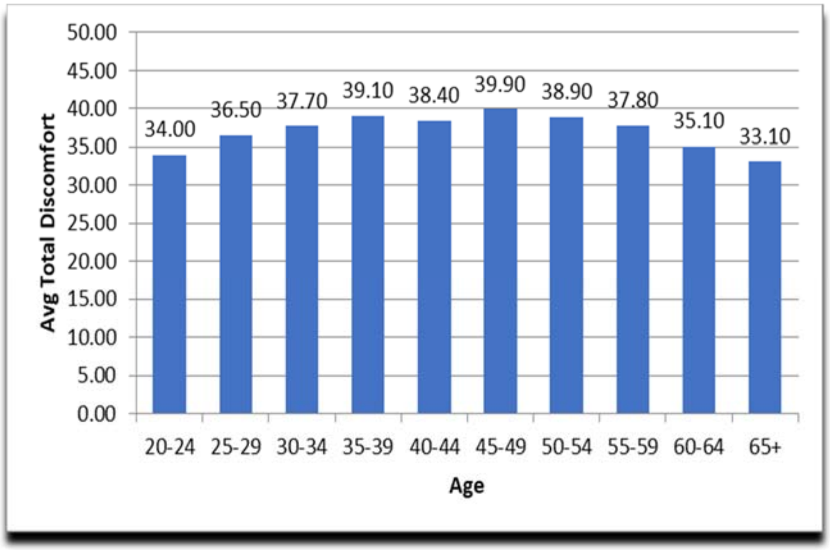



**Figure 23: Age vs. Average Discomfort**

In our data set the youngest age group of employees does not demonstrate the highest average discomfort. In fact, there is no particular age group that demonstrated a significantly higher average discomfort. The original paper hypothesized that there was higher computer use throughout the day in the youngest age group. However, Figure 24 depicts that the current data demonstrates no statistical difference among the age groups in employees using a computer more than 4 total hours per day. It can be concluded that the driving factor in the level of discomfort was computer use, not age.

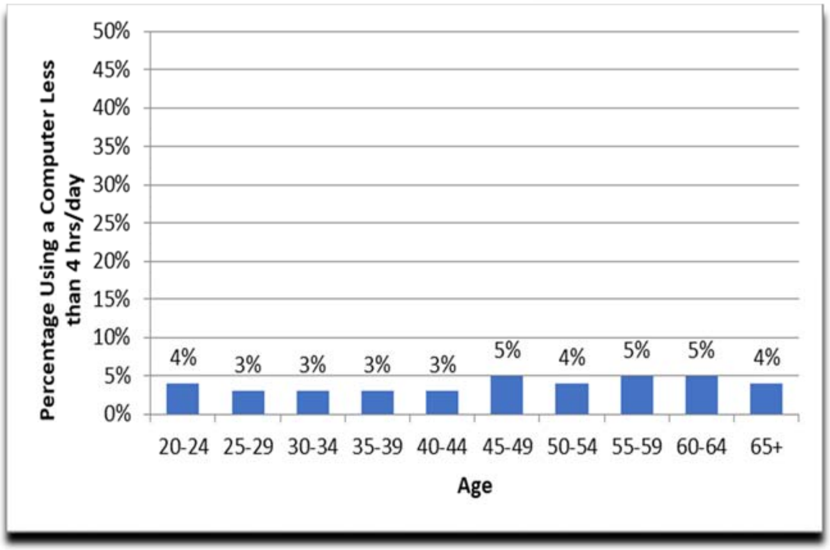



**Figure 24: Age vs Percentage Using a Computer Less than 4 hrs/day**

## Effect of Age on Productivity

Figures 25 demonstrates the effect of advancing age on productivity loss. There is a strong negative correlation between age and productivity loss (r=-.76) demonstrating a decrease in productivity loss as employees age. This data demonstrates that younger employees have a higher incidence of productivity loss without a significantly higher level of discomfort.

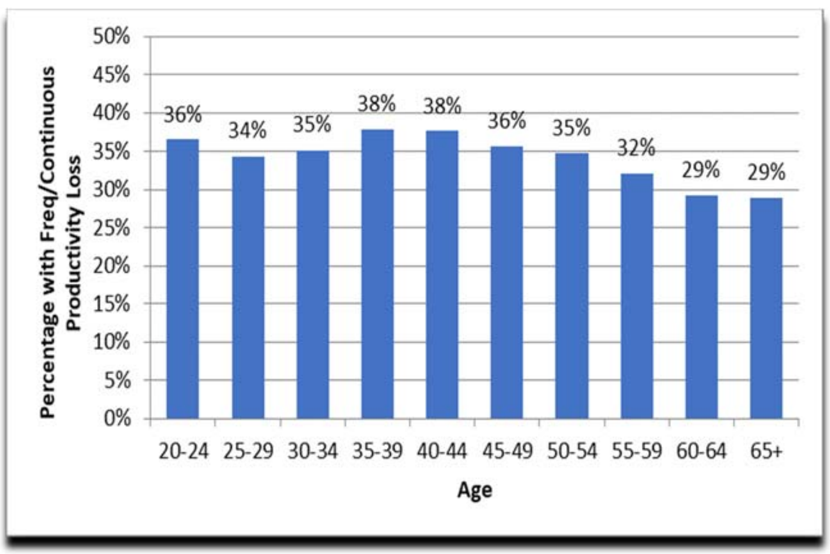



**Figure 25: Age vs. Percentage with Freq/Continuous Productivity Loss**

**Data Summary:**

***Influence of Age/Job Tenure on Discomfort and Productivity***

*There is not a significant difference in overall discomfort when comparing employees' ages. The overall equivalence in daily computer use throughout the age group is one explanation for the discrepancy between the old and new data set. Productivity loss is higher in younger employees. Employees demonstrate statistically similar average total discomfort, but the younger employees demonstrate higher loss of productivity.*

***Comparison to published data***

Salminen, et al discussed the effects of demographics on occupational injuries in their 2017 study. Although their study did not concentrate solely on office environments, they did find similar results. The study investigated age, job tenure, gender, and native tongue. They found that younger age played the largest role in the incidence of injury, even though tenure and age were closely related[4].

***Impact on Approach:***

**Emphasis should be placed on ergonomic modifications and training for younger employees, targeting programs on reinforcing good work habits. This is especially true as the definition of the office has expanded and employees perform work in a large variety of settings. As there is evident higher loss in productivity in the younger age, even with similar discomfort levels, education on self-care, injury prevention and activity modifications will be important aspects of their programs.**

***Job Tenure***

In addition to age, job tenure was addressed. Job tenure is a demographic category that includes the cumulative effect of an individual's work demands, as well as the age of the worker. By further investigating job tenure, we are not only looking at an employee's age but also encompassing the total exposure to work stressors. Figure 26 illustrates that the increase in job tenure does not correlate to higher total discomfort. The correlation between increased job tenure and average total discomfort provides a score of r=0.06 which indicates no relationship between the two factors. There was also no correlation to specific body regions in comparison to job tenure. The three areas of highest level in average discomfort were low back (7.9), head and neck (6.5) and shoulder (5.8). Each of these areas did not demonstrate significant difference between the categories of job tenure.


**Figure 26: Job Tenure vs. Average Discomfort**

## Effect of Job Tenure on Productivity

Figure 27 depicts the effect of longer job tenure on productivity loss. The data demonstrates no significant correlation with productivity loss (r=-.22), and thus the level of discomfort is not affected by job tenure.

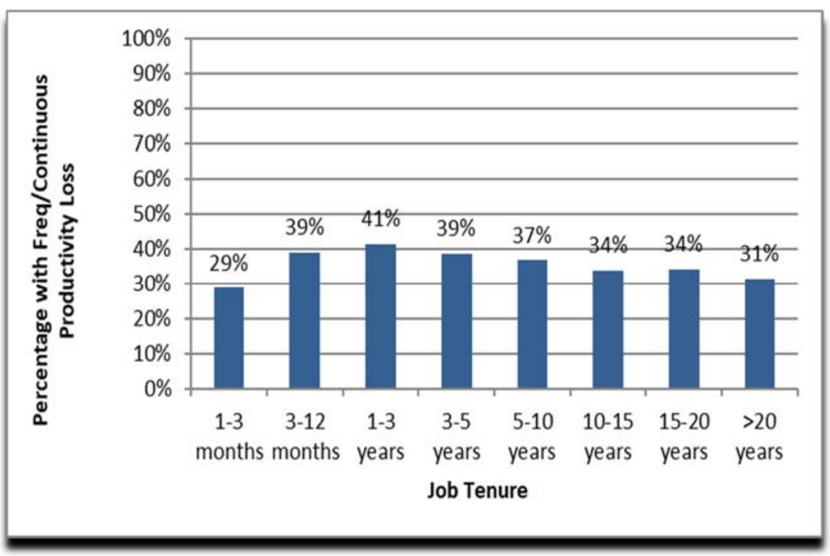



**Figure 27: Job Tenure vs. Percentage with Freq/Continuous Productivity Loss**

## Data Summary:

### *Influence of Job Tenure on Discomfort and Productivity*

*Overall there is not a significant difference in overall discomfort when comparing an employee's job tenure. There is no significant difference in length of job tenure and amount of discomfort or loss of productivity.*

***Comparison to published data***
As seen above in the discussion on age, Salminen, et al discussed the effects of demographics on occupational injuries in their 2017 study. When the study investigated job tenure, it was found that only younger age played a significant role in the incidence of injury, even though tenure and age were closely related[4].

***Impact on Approach:***
**Emphasis should not be placed on the employee's job tenure. There is no link to increased discomfort or loss of productivity.**

***Computer Use***

As discussed above, in the original paper employees in the higher age groups used the computer less frequently than younger employees. With the demand of computing time increasing across the population and professions, there is less of a discrepancy seen between age groups. Because of this, the survey portion of AtlasOffice™ no longer looks at work category of the employee, but focuses on computing time.

In the original study, there was found to be a correlation of $r$=.70 for use of computer and average discomfort. Figure 28 illustrates the relationship between average computing time and average discomfort. There continues to be a strong correlation between amount of computer use and average discomfort ($r$= .85).

There is no significant difference found between the first two exposure categories but approximately twice the overall discomfort with individuals spending over 4 hours a day on a computer. When individual body parts are considered, there is also a significant increase in average discomfort seen in the low back, neck, shoulder and wrist/hand when an employee exceeds 4 hours of daily computing (Figure 29-32).

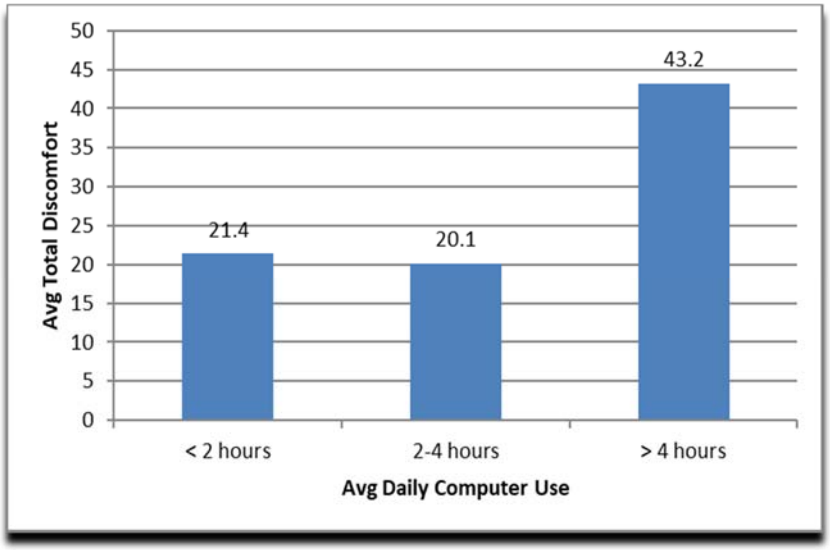



**Figure 28: Computer Use vs. Average Total Discomfort**

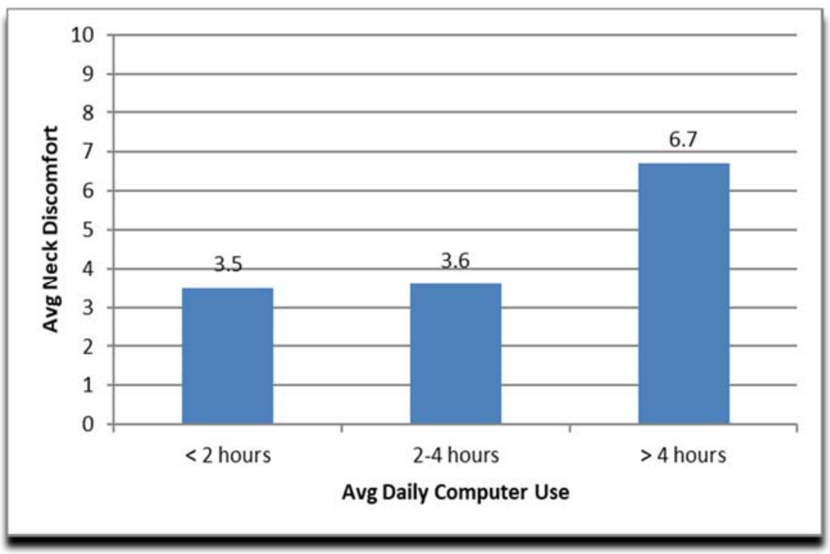



**Figure 29: Computer Use vs. Average Head Neck Discomfort**

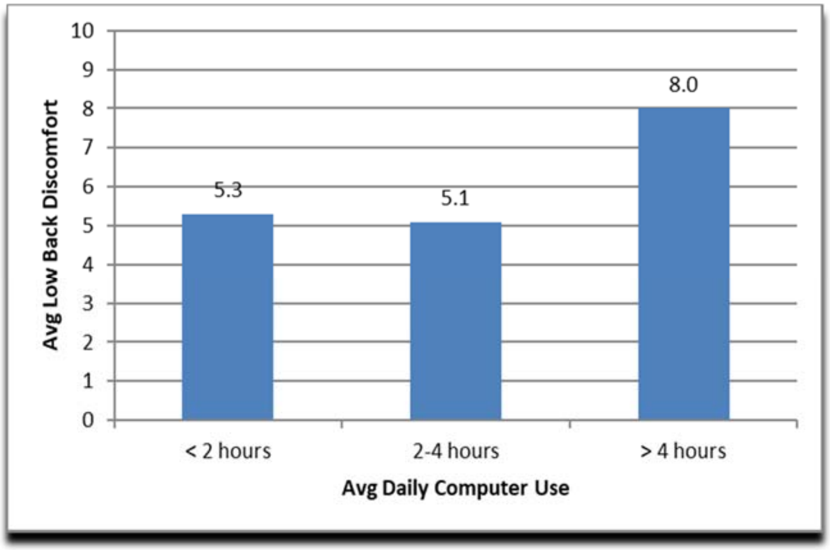



**Figure 30: Computer Use vs. Average Low Back Discomfort**

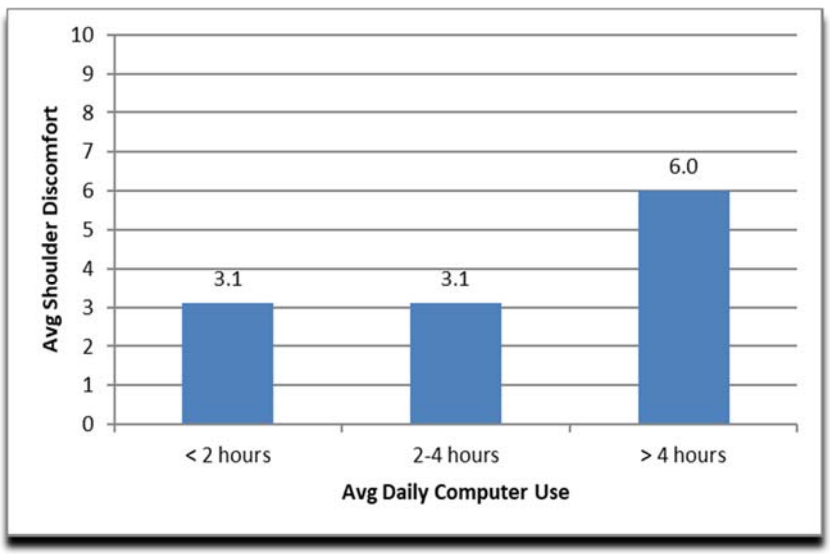



**Figure 31: Computer Use vs Average Shoulder Discomfort**

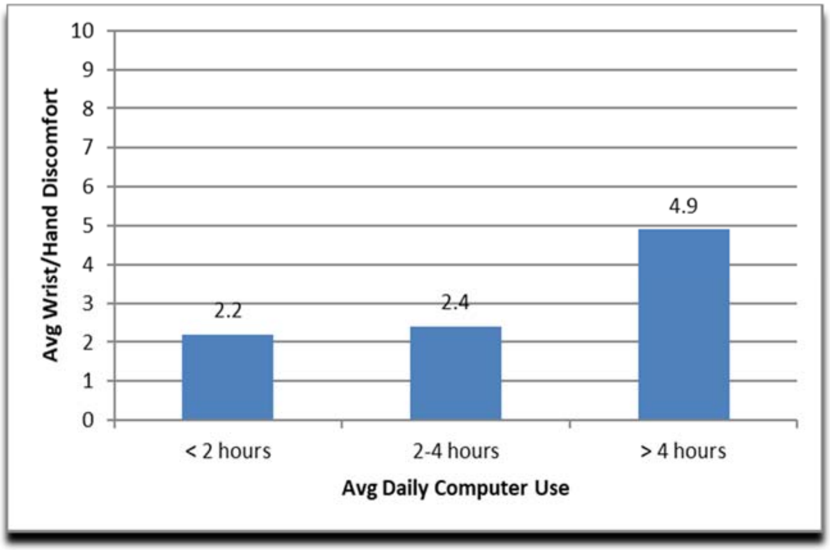



**Figure 32: Computer Use vs. Average Wrist/Hand Discomfort**

**Effect of Computer Use on Productivity**

Although there is a significantly higher number of employees who work on a computer >4 hours per day, the data suggests that there is a significant loss of productivity when employees are using their computer that length of time. Figure 33 demonstrates approximately twice as many employees in this category report frequent to continuous loss of productivity because of their discomfort.

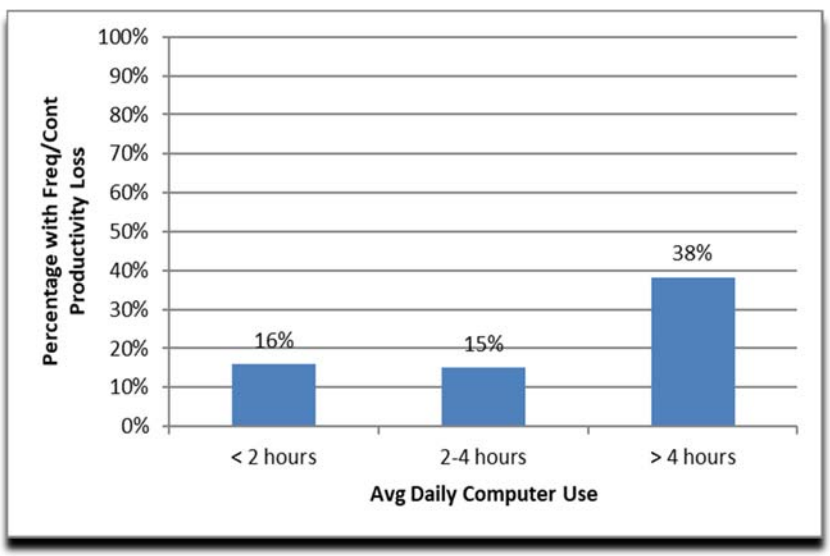



**Figure 33: Computer Use vs. Percentage with Freq/Continuous Productivity Loss**

**Data Summary**:

***Influence of Computer Use on Discomfort and Productivity***
When computer time increases over 4 hours per day, including time at work and home, the likelihood of discomfort in the head/neck, shoulder, wrist/hand, and low back are significantly greater. This extends into loss of productivity as well.

***Comparison to Published Data***

Blatter and Bongers in 2006 and Jun et al in 2017 found similar results. These studies found there was significant increase in discomfort after 4-6 hours of computer work.[5, 6]

***Impact on Approach:***
***Emphasis should be placed on ergonomics programs for workers that spend greater than 4 hours of time on the computer daily. Employees in this category not only have a higher level of discomfort, but also report a significant increase in productivity loss. Although it is important to address acute onset of symptoms upon entering a new position, when addressing workstation ergonomics, precedence should be placed on individuals spending greater than 4 hours on the computer over the tenure at that job.***

**Hand Size**

One new data point that we explored is the employee's hand size. Data demonstrates this to be a significant factor in discomfort as well. Of the total number of responses to the survey, 10,640 responded to the question on size of their hand. When total discomfort is considered, there is an insignificant change in total discomfort between average and large hands, and a 12% increase between average and small hands (Figure 34).

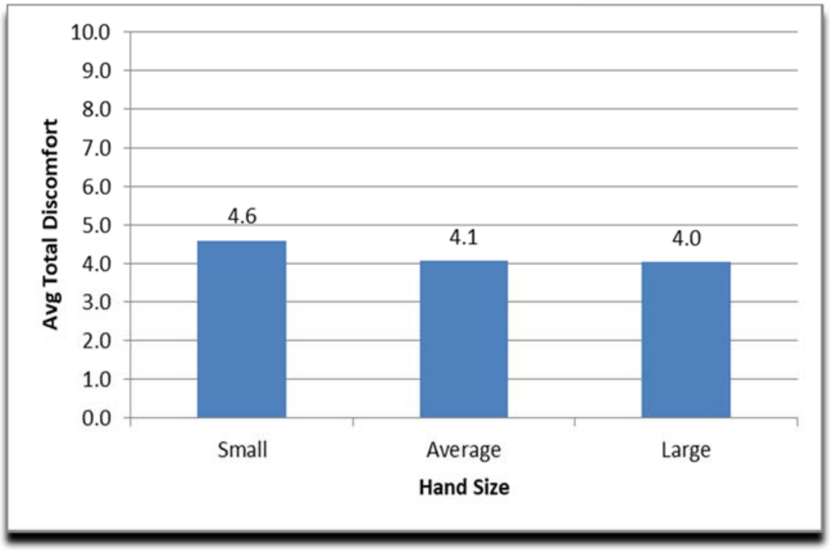



**Figure 34: Hand Size vs. Average Total Discomfort**

When reviewing data on individual body parts, the elbow and wrist/hand did demonstrate a significant increase in the level of discomfort for individuals with small hands (Figure 35 and 36). All other body regions did not show any difference in average discomfort related to hand size.

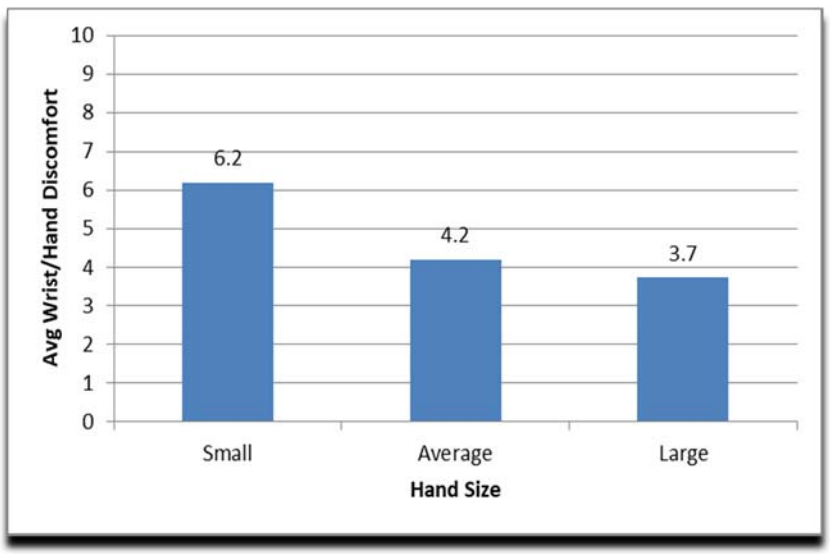



**Figure 35: Hand Size vs. Average Wrist/Hand Discomfort**

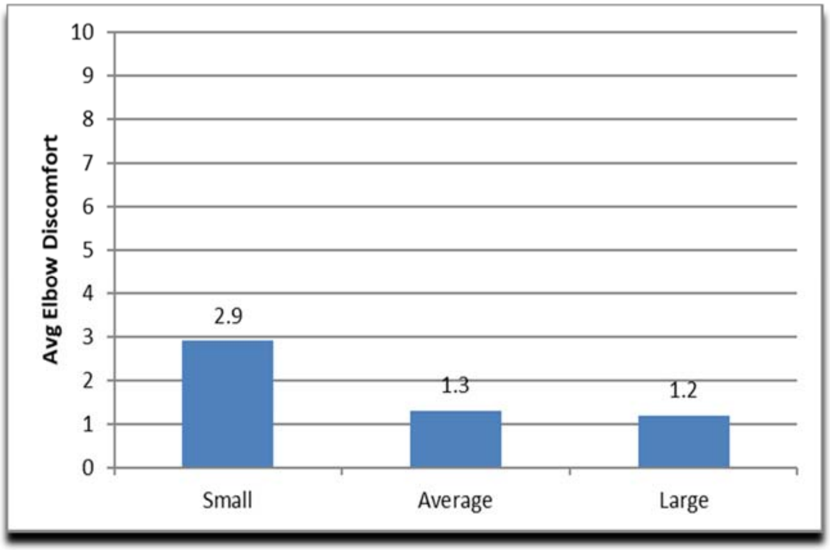



**Figure 36: Hand Size vs. Average Elbow Discomfort**

**Effect of Hand Size on Productivity**
The data suggests that although there is a higher incidence of productivity loss in employees with smaller hands, it is not significantly higher than those with average-size hands. Employees with large hands demonstrate the lowest productivity loss due to discomfort (Figure 37).

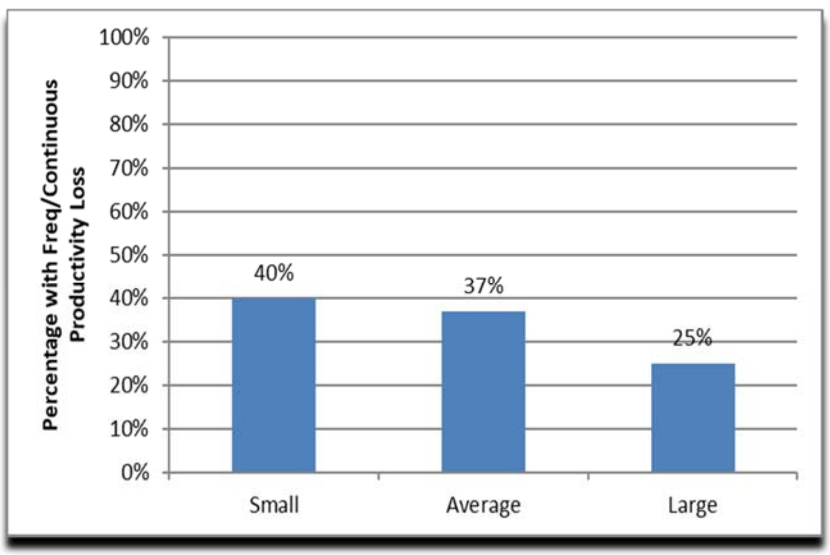



**Figure 37: Hand Size vs. Percentage with Freq/Continuous Productivity Loss**

**Data Summary**:

***Influence of Hand Size on Discomfort and Productivity***
Employees with a small hand size have higher average upper extremity discomfort, especially noted in the elbow, wrist and hand. Other regions of the

body do not exhibit a significant difference. Hand size does not have a significant effect on productivity except for a lower incidence of productivity loss in individuals with larger-sized hands.

### *Comparison to Published Data*

The size of an individual's hand can influence incidence of pain in the upper extremity, specifically the elbow, wrist and hand. This data agrees with published reports supporting the risk for individuals with smaller hands. Galea et al found that individuals with smaller hands may be predisposed to Carpal Tunnel Syndrome as well as other upper extremity disorders.[7]

***Impact on Approach:***
***Emphasis should be placed on ergonomics programs for workers with smaller sized hands. Employees in this category have a higher level of discomfort in the hand, wrist and elbow. Equipment recommendations that allow proper fit for the hand and proper support for the upper extremity should be considered.***

## Gender

The original paper found a significant difference in average discomfort in all body regions and overall discomfort in women as compared to men. However, it was also found a higher portion of the female population had a shorter stature, higher BMI and increased computer use time. Upon our examination of the current data, we found similar findings (Figures 38-42). Unlike in other categories studied, female employees demonstrate higher average discomfort in all regions of the body as demonstrated in Figures 39 and 40.

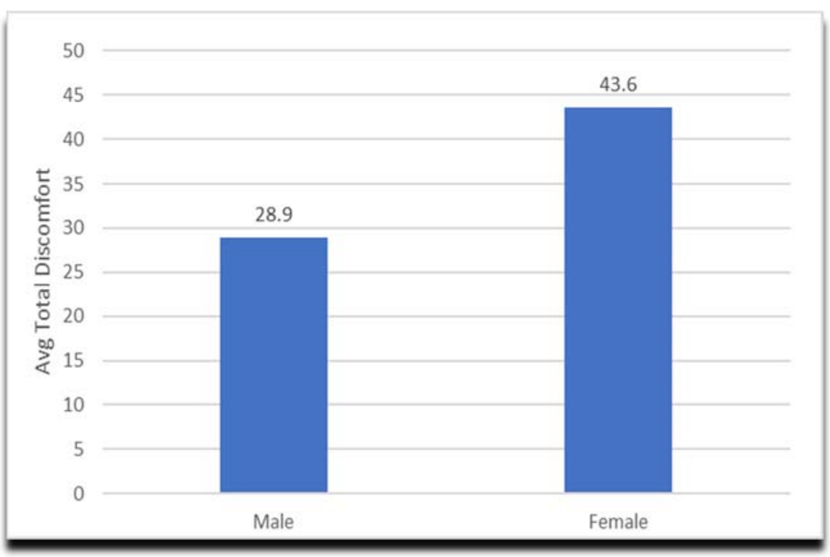



**Figure 38: Gender vs Average Total Discomfort**

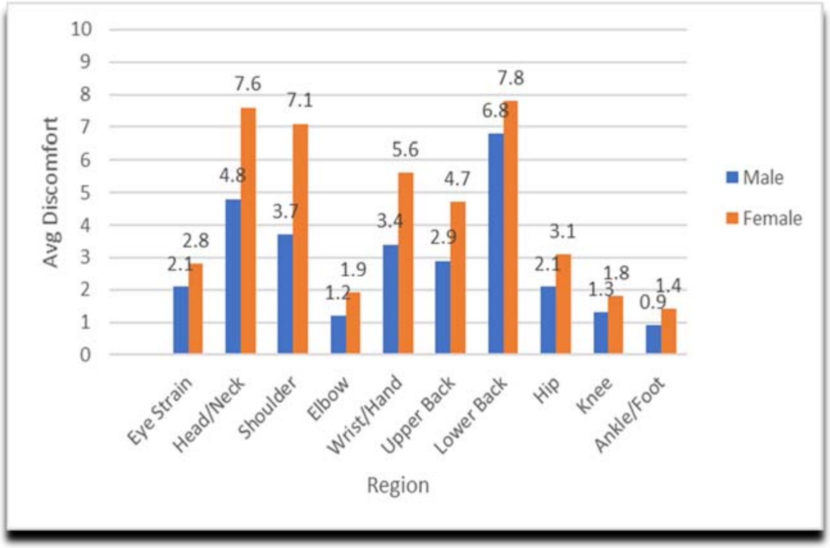



**Figure 39: Gender vs. Regional Average Discomfort**

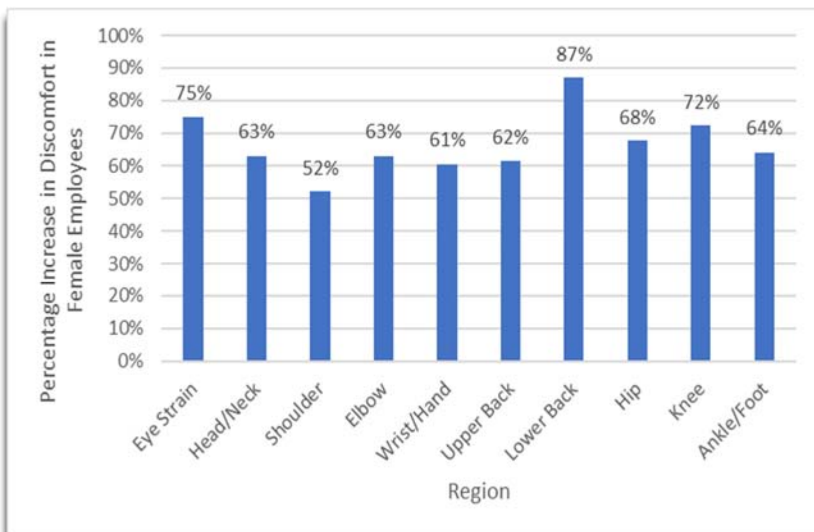



**Figure 40: Percentage Increase in Discomfort in Female Employees by Region**

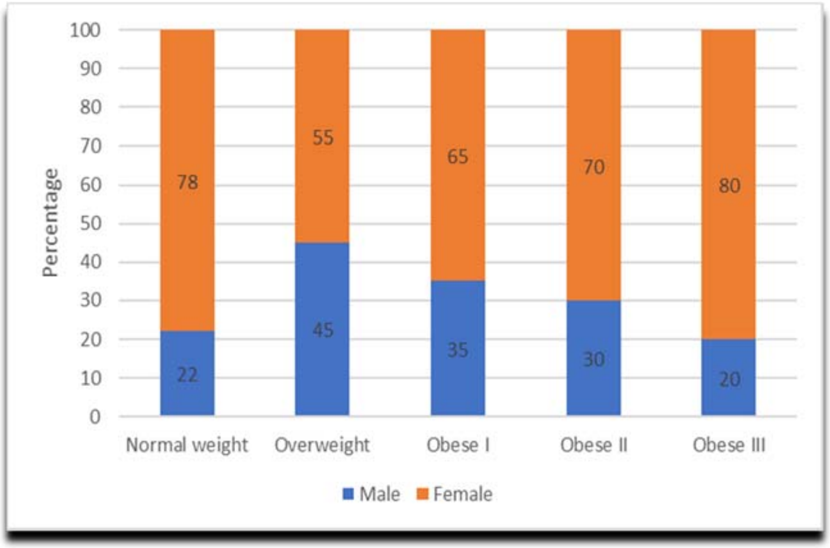



**Figure 41: BMI Classification vs. Gender**

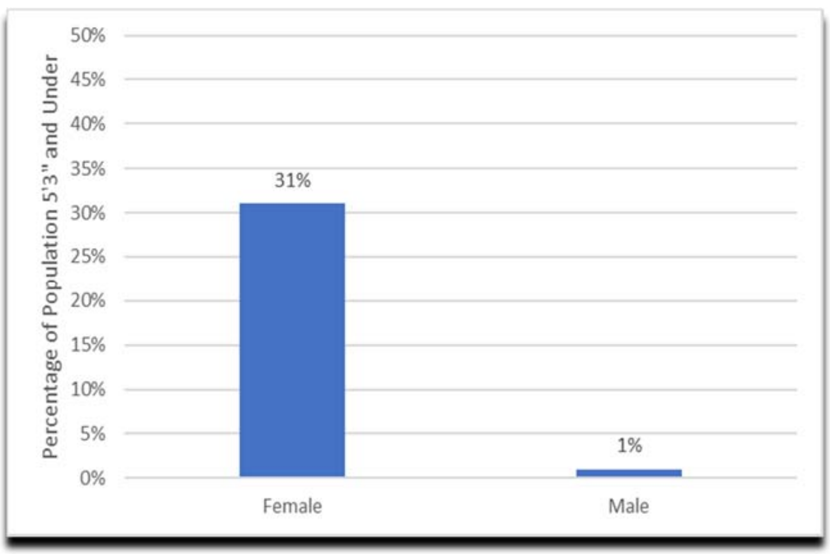



**Figure 42: Gender vs. Percentage of Population 5'3" and Under**

The one discrepancy that was found was in computer use. The current data set looked at computer use in time frames (0-2 hrs/day, 2-4 hrs/day, and >4 hrs/day). There is no significant difference in the percentage of female and male employees working on a computer over 4 hrs/day (Figure 43). The previous paper found the average time use for women was 6.9 hours per day and men was at 6.2 hours per day. Although a small difference, both of these values are above the >4-hour range.

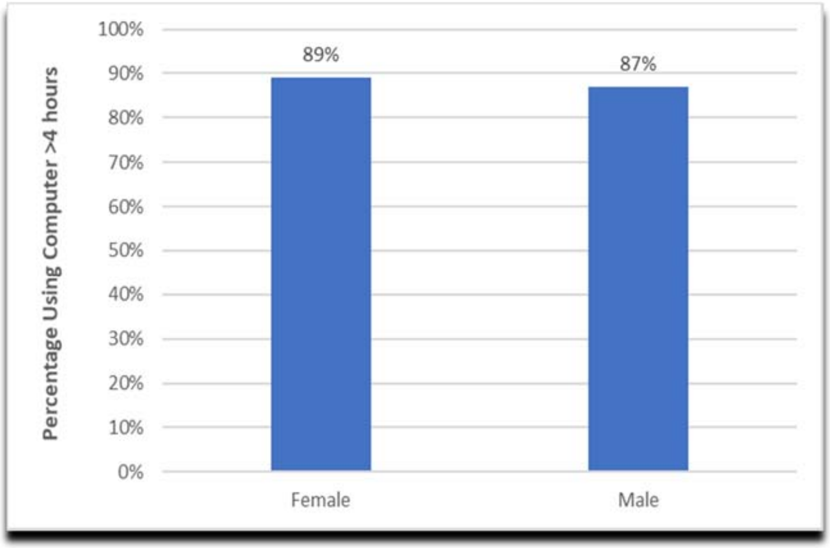



**Figure 43: Gender vs. Percentage Using Computer >4 hours**

One new data point that we explored is the employee's hand size. Figure 44 demonstrates that there is also a significantly larger incidence of smaller hand size in women as compared to men in our population.

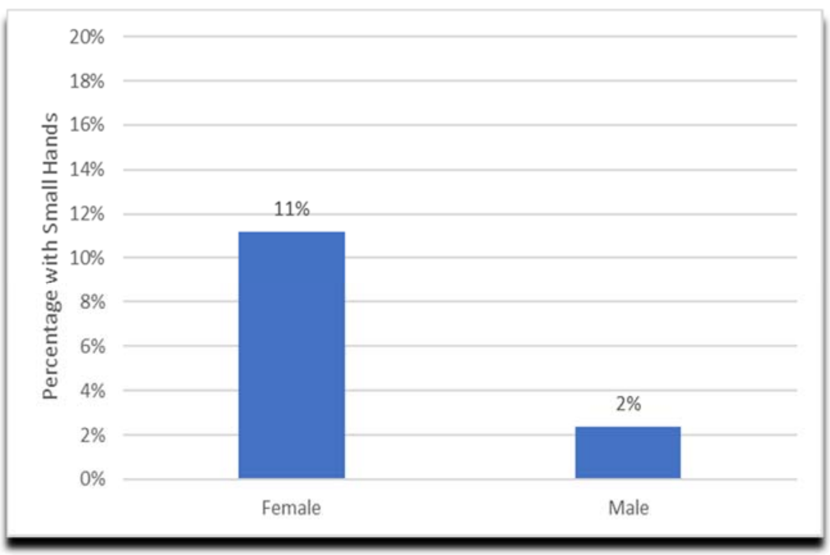



**Figure 44: Gender vs. Hand Size**

**Effect of Gender on Productivity**

The data does not demonstrate any measurable difference between men and women with loss of productivity. Differences in productivity in regard to BMI, height and hand size have been discussed earlier in this paper.

**Data Summary:**

**Influence of Gender on Discomfort and Productivity**

Although there is an increase in average discomfort when comparing women to men, the data does not point to gender as the contributing factor as much as the characteristics of women. Females generally have a shorter stature, higher BMI and smaller hand size. Each of these demographic characteristics lend to the higher rate of discomfort and loss of productivity.

***Comparison to Published Data***

In Salminen, et al study in 2017, they found that gender itself did not play a significant role in higher incidence of workplace injuries. Other underlying physical characteristics played a much larger role[4].

***Impact on Approach:***

***Emphasis should not be placed on gender. Instead, modifications and programs should be placed for employees with smaller-sized hands, those of shorter stature, and in Class II and III Obesity.***

## CONCLUSION

In this update, trends related to the work categories of BMI, height, age, and gender were re-analyzed through an updated larger data set. Job tenure and hand size were also added to the analysis. Recommendations based on the findings are summarized below.

- BMI: *The updated analysis strongly supports the findings of a progressive increase in discomfort and loss in productivity 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 wrist/hand and on employees in any of the obese categories (BMI >30).*

- Height: *The need for emphasis on employees of shorter stature was confirmed in the updated data analysis with expansion to employees under 5'3". Taller employees (i.e. >6'3") should also be prioritized. Emphasis should be placed on obtaining proper support for the neck and both upper and lower back in both of these groups. Programs and solutions to promote proper support and furniture height will not only decrease discomfort but may also improve productivity.*

- Age: *The updated analysis confirms that age is not a significant predictor of discomfort. However, there is a higher incidence of productivity loss in younger employees without a corresponding increase in discomfort. 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 should be considered*.

- *Job Tenure: This is a new area of data collection. It was found to be an insignificant factor in workplace discomfort. Emphasis should not be placed on job tenure for ergonomic modifications and training.*

- Computer Use*: The current data supports that increased computer work correlates to higher level of discomfort and loss of productivity. There is a significant increase in overall discomfort seen in employees that spend over 4 hours a day on the computer. Although the vast majority of individuals spend over 4 hours a day on the computer, the analysis strongly supports that these employees should be targeted for ergonomic analysis*.

- Hand Size: *This is a new area of data collection. Employees with smaller hand size demonstrate higher levels of discomfort in their elbow, wrist and hand. Emphasis should be placed on providing equipment that fits properly and programs to decrease stress on the upper extremities.*

- Gender: *Although there is an increase in total discomfort seen with female participants, there is a significantly higher presence of factors that also place a female at higher risk. Factors including smaller hand size, shorter stature (<5'3"), and higher incidence of obesity are significantly more prevalent in the female than the male participants. Although there was a slightly higher computer use found in the previous paper, both men and women have the same level of use above the 4-hour mark. Emphasis should not be placed on employees due to gender, but should include underlying demographics that place them at higher risk.*

The gathering of demographic data prior to completing an ergonomic office assessment is vital to understanding where emphasis needs to be placed. AtlasOffice™ gives the employee the opportunity to provide this information through an on-line survey before the evaluator begins the assessment. With this information, the provider is better equipped to provide a more effective assessment and better solutions.

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