# Ergonomic Analysis of Factors Causing Musculoskeletal Disorders (MSD) in Heavy Vehicle Drivers

**Asok Kumar N, Regi Kumar V**

***Abstract:*** ***Driving comfort is important for any class of vehicle drivers. Seating comfort is very important for drivers who are undergoing extended period of driving and its associated side effects include higher risk of back problems, discomfort in neck, shoulder and thighs. A good sitting position and correct posture are important for drivers to reduce various work related injuries. There are several occupational risk factors that may affect the work performance of heavy vehicle drivers that may lead to health issues. One of these issues is the driver's exposure to Musculoskeletal Disorders (MSD). MSDs are injuries and disorders that affect the human body's movement or musculoskeletal system. This is due to the fact that heavy vehicle drivers are often exposed to vibration, prolonged sitting and other postural factors. Some are related to the actual driving task, traffic situation, individual variability and cabin layout. The musculoskeletal disorders are mostly associated with work postures and movements, repetitiveness and pace of work, force of movement, vibration, temperature, workplace layout and monotonous tasks. And these mentioned risk factors may affect not only the health of the heavy vehicle drivers but may also cause related road accidents. In order to determine the occupational risk factors, a study is required to identify the current condition of heavy vehicle drivers in relation to major risk factors. Furthermore, this study aims to determine the significant factors affecting the occurrence of musculoskeletal disorders using statistical analyses.***

***Keywords: Driver, Demographic Factors, Experience, Working Hours, Musculoskeletal Disorders.***

## I. INTRODUCTION

Musculoskeletal disorder (MSD) is one of the most common health issues found among working individuals [1]. MSD in body parts are dependent on the nature of job the individual is doing. Individuals engaging driving occupation mostly suffer from neck pain and lower back pain (LBP) [2]. Heavy vehicle drivers who take awkward positions in their seats suffer from both neck and trunk pain [3]. Studies shows that the prevalence of these MSDs can be the result of a mixture of physical, mechanical and psychosocial factors [4]. In a few cases, MSD can damage soft tissues, ligaments, bones, and tendons but in major cases, it could result in long-term diseases, such as spinal degeneration, sciatica, and, in rare cases, tumors [5]. The factors such as the number of miles driven, working hours, awkward posture, whole body vibration (WBV) and individual medical conditions can also be considered for investigations relating MSD [6].

## II. METHODOLOGY

This paper examines the rates of musculoskeletal discomfort in a sample of 110 bus drivers at a public transportation corporation operating in kerala. The data was collected using a Nordic Musculoskeletal Questionnaire (NMQ) enlisting standard questions of all the risk factors and associated details required for the study in appropriate manner after a detailed literature review, consultation with experienced heavy vehicle drivers.

It was collected physical offline mode by direct visit to various bus operating stations and the respondents were asked to fill up the questionnaire enlisting factors to be evaluated. Using the questionnaire the following details were collected:

- Demographic data such as Age, Weight, Height and Body Mass Index(BMI)
- Years of experience
- Working hours per day
- History of MSDs.
- Discomfort levels in locomotor organs.

After the collection of data, they were analyzed to find out the location of discomfort and MSDs among heavy vehicle drivers such that the frequency and extent of pain felt in each body segment can be assessed.

## III. STATISTICAL ANALYSIS

Descriptive measures were used to provide an analysis of summary of collected data to draw appropriate conclusions. Collected data from questionnaire survey, were arranged in such a way that they can be easily interpreted through the use of frequency count and percentage distribution. In addition to this, the gathered data for major risk factors and sub factors considered in the study were statistically treated and subjected to correlation analysis.

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Correlation analysis was used to establish the possible connections between the major risk factors and sub-factors to the severity of MSDs. IBM SPSS Statistics 26.0 is used for data analysis. Descriptive statistics including range, mean and standard deviation is calculated for collected data.
Spearman correlation test is used to determine the relationship between different risk factors and severity of discomfort experienced by various locomotor organs. The locomotor organs considered for this study are listed below:

- Neck
- Shoulders
- Elbows
- Wrist & Hand
- Upper Back
- Lower Back
- Hips & Thighs
- Knees
- Ankles & Feet

Discomfort levels were ranked in a five-point scale (No Discomfort, Mild, Moderate, Severe, Very Severe). Frequency and percentage level of occurrence of discomfort for each organ at different levels among the population of respondents were computed and ranked ordinally.

## IV. DESCRIPTIVE STATISTICS

The age of heavy vehicle drivers ranged between 28 and 54. The mean age was 35.0143±7.6886 years old. BMI values ranged between 21 and 31. No heavy vehicle drivers is underweight, 69% were overweight and 7.27% were classified as obese. The work experience of heavy vehicle drivers ranged between 1 and 24 years with a mean of 14.432 years and standard deviation of 5.62 years respectively. The mean of average work hour in a day of heavy vehicle drivers is 10.29±4.304hours/day.

**Table. 1: Descriptive Statistics**

| Variable | Range | Mean | Standard Deviation |
|---|---|---|---|
| Age | 28-54 | 35.0143 | 7.6886 |
| Height(cm) | 160-178 | 168.1364 | 3.64094 |
| Weight (Kg) | 60-92 | 75.9455 | 8.99626 |
| BMI(Kg/m$^2$) | 22-31 | 26.9792 | 2.48699 |
| Experience (Years) | Jan-24 | 14.432 | 5.6239 |
| Work hours in a day(hour) | Jun-16 | 10.29 | 4.304 |

The study showed that all subjects are having discomfort in any of the 9 body parts. At least 50% of the heavy vehicle drivers either had no discomfort or mild discomfort in elbows, wrist, hips & thighs and ankles & feet. The discomfort in the neck (52.7%), Shoulder (31.7%), Upper back (24.5%) and lower back (41.8%) was severe or very severe. At least 40% of the heavy vehicle drivers complained about moderate pain in knees. Another significant locomotor organ where discomfort reported was in ankles/feet of about 32.7%. It was also showed that 31.4% and 37.5% of the heavy vehicle drivers are having moderate pain or discomfort in upper back and lower back respectively. It was reported that mild discomfort is bearable, moderate discomfort needs medications and severe discomfort causes lack of ability in doing daily task.

**Table. 2: Body Discomfort Level Chart**

| Body Part | Severity of Discomfort (%) | | | | |
|---|---|---|---|---|---|
| | No Discomfort | Mild | Moderate | Severe | Very Severe |
| Neck | 20.9 | 10 | 16.4 | 40.9 | 11.8 |
| Shoulder | 31.8 | 13.6 | 21.8 | 31.7 | 0 |
| Elbow | 44.5 | 30.9 | 24.5 | 0 | 0 |
| Wrist | 51.8 | 20 | 24.5 | 3.6 | 0 |
| Upper Back | 16.4 | 11.8 | 47.3 | 22.7 | 1.8 |
| Lower Back | 11.5 | 10.9 | 31.8 | 30 | 11.8 |
| Hip & Thighs | 33.6 | 30 | 29.1 | 5.5 | 1.8 |
| Knees | 30.9 | 21.8 | 41.8 | 5.5 | 0 |
| Ankles & Feet | 30.1 | 25.5 | 32.7 | 2.7 | 0 |



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## V. SPEARMAN CORRELATION ANALYSIS

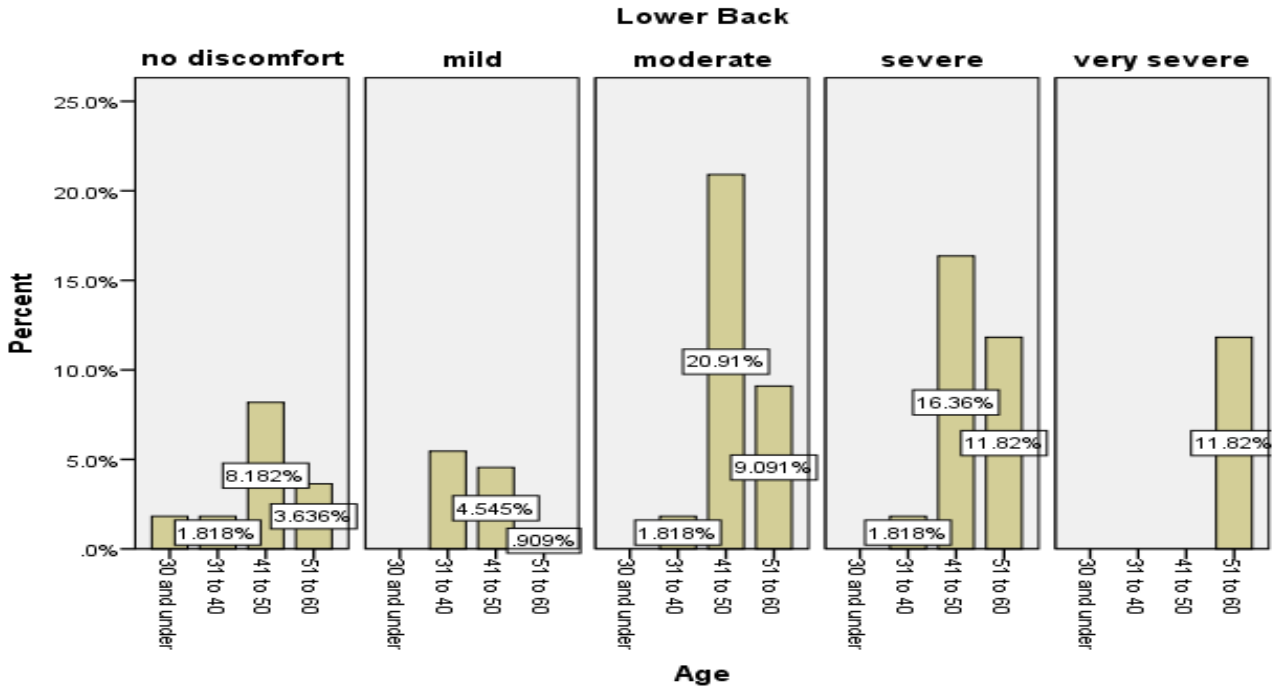


**Fig. 1: Percentage of heavy vehicle drivers experiencing discomfort in neck in various age groups.**

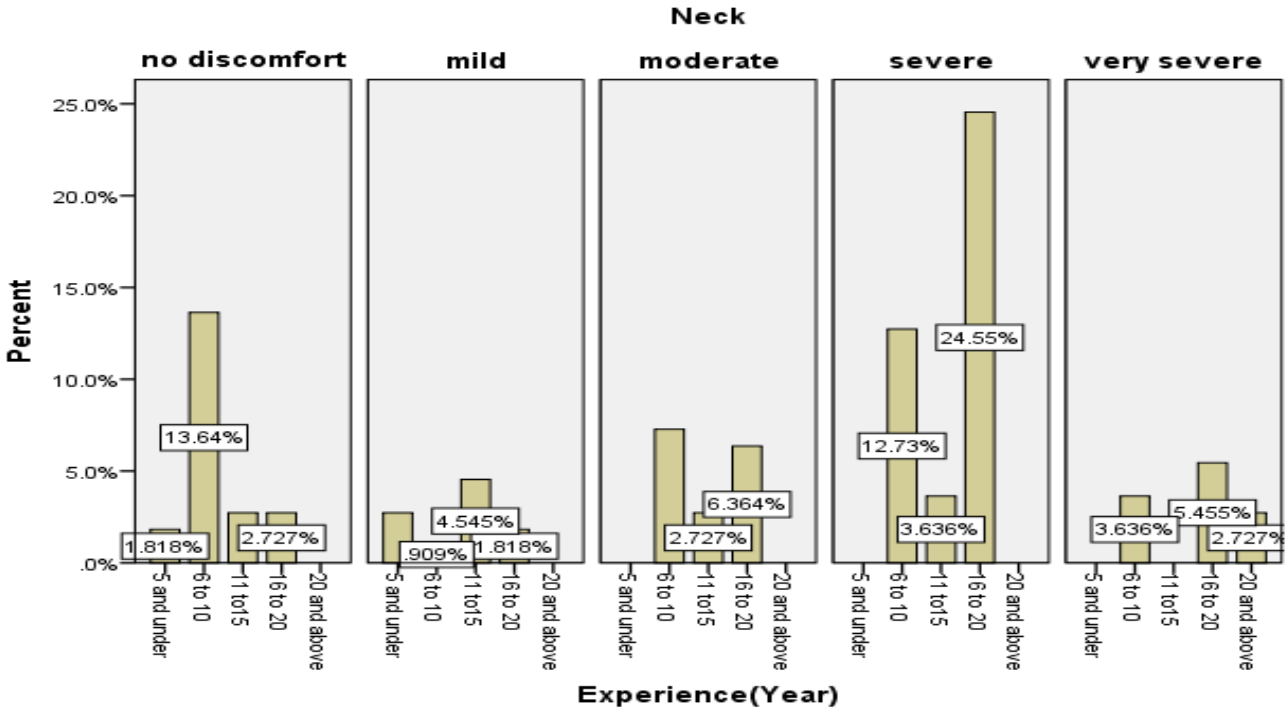


**Fig. 2: Percentage of heavy vehicle drivers experiencing discomfort in lower back having different period of work experience.**

If the value of correlation coefficient is positive, relationship is direct and if it is negative, the relationship is inverse. Relationship between age and discomfort in all regions were direct and it is significant for work experience and discomfort in neck, shoulders, upper back, lower back, one or both knees and one or both ankles/feet at $p<0.05$. Height is having direct relationship with weight, BMI is having direct relationship with height and weight and it is significant for discomfort in one or both knees at $p<0.05$. Work experience is having direct relationship with all subjects relating to locomotor organs except wrist and hands and significant at $p<0.05$. Working hours/day is having positive relationship with work experience and discomfort in neck, shoulders and lower back at $p<0.01$ and significant.

**Table. 3: Correlation between Demographics, Experience, Working Hours and MSDs in Heavy Vehicle Drivers**

| | Neck | Shoulders | Elbows | Wrist /Hand | Upper Back | Lower Back | Hips/ Thighs | Knees | Ankles/ Feet |
|---|---|---|---|---|---|---|---|---|---|
| **Age** Correlation Coefficient Sig. (2 Tailed) N | .286** .002 110 | .254** .007 110 | .165 .085 110 | .033 .731 110 | .256** .007 110 | .451** .000 110 | .007 .939 110 | .241* .011 110 | .273** .004 110 |
| **Height** Correlation Coefficient Sig. (2 Tailed) N | .135 .160 110 | .257** .007 110 | -.046 .636 110 | -.137 .153 110 | .064 .504 110 | .188* .049 110 | -.052 .588 110 | -.088 .359 110 | .183 .056 110 |
| **Weight** Correlation Coefficient Sig. (2 Tailed) N | -.053 .583 110 | -.077 .423 110 | -.122 .203 110 | -.197* .039 110 | -.131 .172 110 | .030 .760 110 | -.174 .069 110 | -.306** .001 110 | -.026 .791 110 |
| **BMI** Correlation Coefficient Sig. (2 Tailed) N | -.183 .055 110 | -.179 .062 110 | -.097 .422 110 | -.091 .347 110 | -.165 .084 110 | -.112 .249 110 | -.162 .092 110 | -.323** .001 110 | -.172 .073 110 |
| **Experience (Year)** Correlation Coefficient Sig. (2 Tailed) N | .421** .000 110 | .439** .000 110 | .240* .011 110 | .090 .347 110 | .341** .000 110 | .515** .000 110 | .078 .416 110 | .160 .096 110 | .323** .001 110 |
| **Work Hours/day** Correlation Coefficient Sig. (2 Tailed) N | .302** .001 110 | .291** .002 110 | .027 .781 110 | -.087 .367 110 | .125 .194 110 | .324** .000 110 | .016 .868 110 | .023 .810 110 | .085 .378 110 |

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

## VI. CONCLUSION

Musculoskeletal disorder (MSD) represents a major occupational health issue and its prevention and reduction are very important for any class of vehicle drivers. The extended period of driving in the limited ergonomic work environment causes the occurrence of MSDs and its prevalence is very high in heavy vehicle drivers. The symptoms of MSDs increase with the number of years of work experience. The study establishes high prevalence of MSDs especially in neck, shoulders, upper back and lower back among heavy vehicle drivers due to this factor. The study showed that age is a risk factor which causes MSDs in many locomotor organs. The symptoms of MSDs increase with the number of years of work experience and age in heavy vehicle drivers are important reasons for high prevalence of MSDs in neck, shoulder, upper back and lower back. MSDs can be reduced with proper rest and providing better working environment using ergonomics principles.

## DECLARATION

| | |
|---|---|
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