



Are Bus Drivers at an Increased Risk for Developing Musculoskeletal Disorders? An Ergonomic Risk Assessment Study

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Rec date: February 25, 2015; Acc date: March 12, 2015; Pub date: May 20, 2015

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Abstract

Background: Work-related musculoskeletal disorders (WMSDs), especially low back pain and neck pain cause substantial socio-economic losses. Professional drivers are particularly at high risk for developing back pain and neck pain from prolonged sitting and vehicular vibration. This study assesses ergonomic exposure on the developmental risk of WMSDs among bus drivers.

Methodology: A total of 280 male drivers with acute body pain in any region were randomly selected for the study, and ergonomic information on driver's seat was collected using a validated questionnaire. Then the exposure and risks of developing WMSDs were assessed using Quick Exposure Check (QEC), Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA) and Nordic Musculoskeletal Questionnaire (NMQ).

Results: The results of QEC showed that back and shoulder had very high exposure followed by neck and wrist. REBA revealed that nearly half (46%) of the drivers were at high risk of developing WMSDs, whereas 14% were at very high risk and 29% were at medium risk. As per RULA, 46% of bus drivers needed further ergonomic investigation and modification of workstation/work style, indicating that the risk for WMSDs is potentially high. Among others, 29% were at moderate risk and 14% were at low risk, whereas 11% were at very high risk, requiring immediate change. From NMQ, it was found that 26% of drivers had musculoskeletal problems in the neck, 24% in the back, 20% in the upper limbs (shoulder and wrists were equally affected), 6% in the knees and 4% in the ankles.

Conclusion: The current study evaluated the risks of developing WMSDs among bus drivers. Exposure to unsafe ergonomic practices/conditions and health risks were evident from the findings of the study. Prospective studies are necessary to confirm the cause and effect in this association. Ergonomic intervention measures with workplace health promotion activities need to be implemented in order to reduce the risk of WMSDs among bus drivers.

Keywords: WMSDs; Risk; Bus Drivers

Background

Work-related musculoskeletal disorders (WMSDs) are painful disorders of muscles, bones, nerves, tendons and other soft tissues due to workplace activity. WMSDs are responsible for morbidity in many working populations and are known to cause significant occupational problems with increasing compensation and health costs, reduced productivity, and lower quality of life [1]. WMSDs are a serious public health problem given the high cost to the injured worker, his or her family, employers, and society to a large extent. WMSDs are considered to be multifactorial that are caused due to the interactions between various risk factors, which result in conditions that vary across different occupations [2]. Particularly, low back pain and neck pain being common forms of WMSDs cause substantial economic losses to individuals as well as to the community. Professional drivers have been found to be at high risk for developing back pain due to prolonged sitting and vehicular vibration [4-7].

Importantly, WMSDs in professional drivers are associated with ergonomic as well as psychosocial risk factors. The most commonly

identified physical factors are prolonged sitting, whole-body vibration, ergonomic mismatch, i.e., disparity between anthropometric sizes of the drivers and their physical environment including driving mechanisms (automatic or manual, etc.). Individual factors such as age, gender, weight, height, body mass index, and general health status are also associated with work-related ailments of drivers. In the United States, between 1992 and 1997, approximately 5% of the Tri-Met bus-driver-workforce compensation claims were directly attributed to the design of the bus operator's seat. These claims had costed over \$204,000 that amounted to 23% of the total cost of all compensation claims filed for that five year period [10]. Appropriate intervention measures can significantly reduce the incidence and severity of musculoskeletal injuries. It is estimated that proper ergonomic design can reduce up to one-third of compensable occupational low-back pain. Posture of the seated person is dependent on the design of the seat itself, the work to be performed and individual sitting habits. Seated posture is defined as the body position in which weight of the body is transferred to a supporting area - ischial tuberosities of the pelvis and their surrounding soft tissue. The biomechanical considerations of seated postures include the spine, arms, and legs. Muscles at the back of the thighs influence the relative position of

spine and pelvis. The location and slope of the work area influence the position of neck, shoulders, and upper extremities when an individual is in a seated posture. Therefore, it is essential that not only the seat but also the work to be performed also needs to be taken into consideration [11,13].

The driver's cabin is the area from which the driver directly controls the operation of the bus. The seat, steering wheel, and pedals influence the drivers' posture. Hence, knowing about the position/orientation of driver's seat, steering column, wheel, and pedals in the driving cabin is necessary to understand the causal factors of musculoskeletal injury and discomfort. Bus manufacturers, however, often overlook the necessity of designing the driver's seat ergonomically as an integral part of the driver's cabin. Bus drivers often do some temporary modification of the seat to improve their level of comfort which would most likely interfere with the functionality. Consequently, the incompatibility between comfort and function would result in injury to the driver in the long run.

The risk factors of WMSDs among drivers would vary between countries due to differences in racial background, geographical location, ethnicity and socio-demographics. Although considerable epidemiological studies have explored and reported on musculoskeletal disorders among occupational drivers, few studies have been conducted in India to date. This study focuses on assessing personal as well as ergonomic risk of developing WMSDs among a sample of bus drivers in their current occupational settings in Chennai, India.

Methodology

The study was conducted in University bus depot of Chennai City, which is the capital city of the Tamil Nadu, a southern Indian state. Chennai is the fifth-largest city and fourth-most populous metropolitan area in the country and 31st largest urban area in the world having population of 4.7 million. A total of 280 bus drivers with acute body pain in any region who produced informed consent, were considered as cases and included for the study with simple random sampling. Drivers with a history of traumatic road or work accidents were excluded from the study. As the research interest is to know the current exposure and risk levels for WMSDs among drivers; could be the potential reason to exclude healthy bus drivers from this study. A structured pre-tested interview was conducted to collect information using the standardised pre-validated tools- driver seat ergonomics questionnaire, Quick Exposure Check (QEC), Rapid Entire Body Assessment (REBA), Rapid Upper Limb Assessment (RULA), and Nordic Musculoskeletal Questionnaire (NMQ).

Driver seat ergonomics questionnaire contains basic demographic information as well objective measurement of their seat with standard inch tape. QEC is an observational method used to assess the level of exposure to ergonomic risks, which provides 4 categories for estimating the risk level. These risk levels named from 1 to 4 are corresponding to low, moderate, high and very high levels of risk respectively. REBA is a postural targeting method for estimating the risks posed by work anywhere in the body. A REBA assessment gives a quick and systematic assessment of the complete body postural risks to a worker. As the posture moves away from the neutral position, the risks score increases. RULA ergonomics technique evaluates individuals' exposure to postures, forces and muscle activities that have been shown to contribute to the risk of development of WMSDs. The result is a risk score between one and seven, where higher scores

signify greater levels of apparent risk .To identify the body parts having significantly higher frequencies of musculoskeletal problems the NMQ has been used as part of a focused study on musculoskeletal issues . Descriptive statistics (mean, standard deviation and percentage) was used to summarize the data. Data analysis was performed using R statistical software (3.0.1 version) .

Results

The mean age of 280 male bus drivers was 34.6 ± 9.5 (Mean \pm SD). The demographic data of bus drivers in Table 1 shows that more than 60% of drivers had been driving since the past>5years. Among all, about 80% drivers were smokers and 68% of the subjects reported that some occasional alcoholic drinks. Education of all drivers was satisfactory, as only 20% of all drivers were not having any formal education. Though the mean weight of drivers was 60 ± 11 (in kg), the body mass index (BMI) shows 25.5 ± 4 , indicating that almost all drivers were overweight. The physical activity level of all drivers found to be very poor as only 12% of drivers involved themselves in sports or other non-professional physical activities. For Moderate, High and Very High scores, there are likely to be several interactions that should be identified and reduced. It is also possible that one or two interactions are at the highest levels (i.e. 10 or 12) of exposure. These should be addressed urgently. These interactions should be monitored and reviewed as it may cause injury to the body in the long run. The current personal exposure of bus driver's assessed using QEC showed that back and shoulder are the regions of very high exposure as compared to the neck and wrist regions. Overall, the level of exposure was low among the study group. Even if the exposure score is Low, it is important to note that one or two interactions may be contributing disproportionately to the score (i.e. a score of 8 or more); as shown in Table 2.

Characteristic	Percentages
Age	
25-35	68%
35-45	25%
45-55	07%
Education	
Illiterate	20%
Primary	25%
Secondary	55%
Work Experience	
<5 years	40%
>5years	60%
Smoking	
Non- smokers	20%
Smokers	80%
Alcohol Consumption	
Alcoholic	68%
Non-alcoholic	32%
Sports Activity	
Yes	12%

No	88%
Height (in m)	1.61 ± 0.12
Weight (in kg)	60 ± 11
BMI (Kg/m ²)	25.5 ± 4

Table 1: Demographic Characteristics of Drivers.

Body Region	Low (%)	Medium (%)	High (%)	Very High (%)	High
Back	46.42	21.42	17.85	14.28	
Neck	53.57	17.85	25	3.57	
Shoulder	46.42	28.57	17.85	7.14	
Wrist/Hand	39.28	25	32.14	3.57	

Table 2: Levels of Exposure among Drivers.

Pertinent Body Dimensions	Observed Value (in cm) Mean ± SD	Standard Value (in cm) SAE Referred Value
Distance from floor to under thigh with leg vertical	31.19 ± 2.21	20-25 (Adjustable)
Distance from chair backers to back of Knee	47.93 ± 3.66	42-58 (Adjustable)
Distance from seat cushion to base of neck	51.41 ± 3.27	55 ± 30
Width of driver's Seat at Shoulder Level	47.69 ± 4.42	43 ± 20
Width of driver's Seat at Girth (Measured at navel)	31.64 ± 3.49	50 ± 20
Width of driver's Seat at buttocks when seated	25.01 ± 3.11	-----

Table 3: Ergonomic Measurements of Driver's Seats.

Risk assessment score (REBA) revealed that 46% of bus drivers had high risk, while 14% had very high risk of developing any type of WMSDs. Among all, 29% of bus drivers had medium risk, whereas a very few (4%) had negligible risk of developing WMSDs. RULA score indicates that 46% of bus drivers needed further investigation and rapid modification of workstation/work-style, indicating that the risk is high. Similarly, 29% had moderate risk and 14% had low risk of developing WMSDs. But 11% of bus drivers were found to have very high risk, indicating the urgency to implement change as indicated in Figure 1.

In this study, the musculoskeletal complaints of bus drivers were high in the neck (26%) and back (24%) regions. The shoulder and wrist regions were equally affected with 20% reporting pain. The regions of lowest complaints were knee and ankle, with complaints from 6% and 4% of bus drivers respectively as shown in Figure 2.

Almost all drivers complained the same symptoms (as collected in drivers' ergonomic questionnaire) without work duty as well on the off days or week-ends, which clearly indicates that symptoms were work-related. This has been found that, reported body part pain correlates with the higher exposure on the same part. As 30% of driver's shown high exposure on the neck region and same time 26% reported neck pain. Similarly 32% have high exposure on the lower back; while 24% reported Low back pain (LBP). The exposure to reported pain

The seat design, which is a direct contributing factor for postural related physical pain, must also consider the physical characteristics of the driver and the accommodations required that permit the full range of seat adjustments. So a seat ergonomics and dimensions were measured and compared with the International standards of bus/truck drivers' seat by Society of Automotive Engineers-International Ergonomics Association (SAE-IEA) as shown in the Table 3. Because of dearth of ergonomics studies in India lack of National guidelines on Seat Ergonomics, authors tried to compare with International guidelines in this study. Varied seat diameters have been observed among the drivers; which might be because of lack of a standard protocol for seat ergonomics in countrywide. All of the seats observed had neither good cushion for back and neck nor any provision for adjustment. Also, some drivers got habituated to use a separate cushion in their seats according to personal comforts.

proportion remains same in neck region but in lower back it reduced; because of higher functional adaptation on the lower back region.

Discussion

Our study showed a 26% self-reported 12-month prevalence of neck pain among the participant professional bus drivers, followed by a 24% prevalence of back pain and 20% prevalence of shoulder and wrist/hand pain. Existing literature is ambiguous regarding prevalence of neck and upper limb pain in professional drivers. Szeto and Lam [19] found that prevalence of neck pain in Hong Kong bus drivers was 49%.

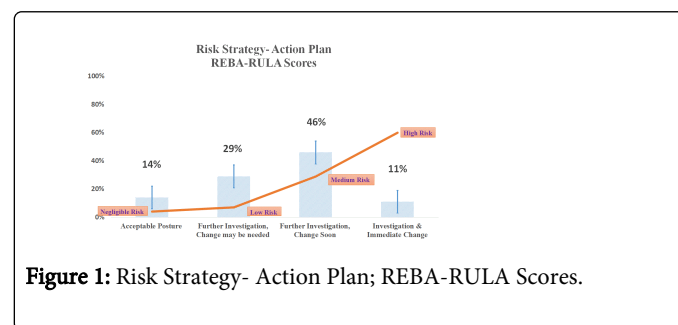


Figure 1: Risk Strategy- Action Plan; REBA-RULA Scores.

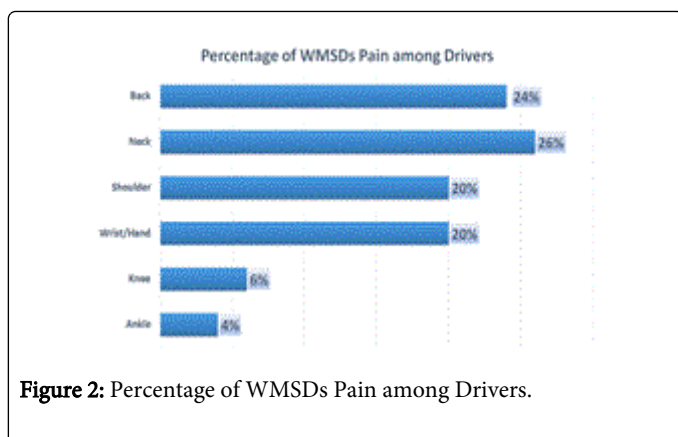


Figure 2: Percentage of WMSDs Pain among Drivers.

Our study indicated a 24% prevalence of LBP among drivers, which is comparable with a recent report by Robb and Mansfield [20] who found a 60% prevalence of LBP among professional truck drivers over 12 months, and with another study among Taipei urban taxi drivers where the prevalence over 12 months was found to be 51% [1]. Netterström and Juel [22] evaluated the occurrence of LBP among 2045 professional urban bus drivers in Denmark, and found a 57% prevalence of frequent LBP. In a study on a group of American and Swedish bus drivers (Magnusson et al. [23]) studied, a 60% prevalence of LBP was found, that required, on average, 18 days of sick leave. The relatively lower prevalence of LBP that was found in the present study can probably be attributed to lower reporting and ignorance about the WMSDs. The 12-month LBP prevalence is still very high among drivers and additional studies are needed to identify the hazards as well as develop prevention strategies. In the present study, an uncomfortable seat and uncomfortable back support were found to be associated with a higher prevalence of LBP among professional bus drivers. Bus drivers often maintain awkward body postures for extensive periods during their work. These postures include slumped sitting, leaning on one side, bending and twisting, and excessive reaching. Drivers might adopt awkward postures to avoid discomfort caused by a poor ergonomic chair. These positions, combined with an uncomfortable chair, can place mechanical stress upon the spine and its surrounding soft structures and ultimately cause back pain. A poor ergonomically designed chair, with an uncomfortable seat and back support in combination with an incorrect steering wheel position, may cause or contribute to awkward body postures; also, prolonged sitting and driver-seat mismatch were found to be significant occupational risk factors for neck and back pain in the Hong Kong bus drivers study by Szeto and Lam [19]. It best explains our study findings. Scores of RULA and REBA indicated that risk was very high and further investigations were required. Approximately, half of the studied drivers had higher risk of developing WMSDs, thus indicating poor ergonomics which needs immediate attention. Subjective evaluation of workstations revealed that the workstation height and seat dimensions were inappropriate, and did not meet the criteria of the International standards of bus/truck drivers' seat by the SAE-IEA.

The current study found lower proportion of drivers involved in physical activity; thus all having some form of WMSDs pain during the survey; this finding is consistent with previous study by Morken et al. [24] who concluded that; a physically active lifestyle both at work and at leisure was associated with fewer musculoskeletal disorders among personnel. Physical fitness for duty is an important medical component for readiness and an integral part of the fit and healthy

force pillar of health protection [25,26] for all formal occupational sectors. Considering driver professionals; such requirements of physical fitness has not been standardized countrywide; which suggests there is an urgent need for universal physical fitness guidelines for different occupations in India; thus improving physical fitness could prevent or reduce the incidence of MSDs.

Conclusion

The current study evaluated the risk of developing WMSDs in bus drivers exposed to current ergonomic conditions. Study reveals that; exposure to unsafe ergonomics and postural risks among bus drivers were evident from the findings of Exposure (QEC) and Risk (REBA, RULA) scores. It also was found that less involvement in physical activity among the studied drivers resulted in to the higher risk of WMSDs. The reported body region pain has the higher exposure. Among all the body part neck and back region pain found to be higher. As more than half of drivers have the higher risk of developing WMSDs it have been indicated that further ergonomic investigation and proper ergonomic intervention is much essential.

The limitations of this study include in its design; as a short case study design did not allow us to study the influence of workstation comfort and risk factors on the incidence of musculoskeletal complaints. Prospective studies are necessary to confirm the cause and effect in this association. Another limitation would be; the work postures were observed only once for a brief period of about 15 minutes for each subject. Information on sick leave and the effect of musculoskeletal symptoms on work and leisure activity was not able to collect by the researchers; because of lack of proper documentation.

Despite these limitations, this study was able to add evidence of unsafe ergonomics among bus drivers in their occupation who are prone to have higher risk for WMSDs. A physical activity regimen should be devised for all drivers and they are encouraged to participate in extra-curricular physical activities to minimize the incidence of WMSDs. Ergonomic intervention with workplace health promotion was recommended to reduce WMSDs among bus drivers.

Acknowledgements

We are thankful to participants of the study who gave us unconditional support, and the concerned authorities of QEC, REBA, RULA and NMQ for permitting us to use their respective tools for this research study.

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This article was originally published in a special issue, entitled: "**Driver Safety**", Edited by Jibo He