

## Evaluation of Whole Body Vibration and Back Pain Problem Among Light Rapid Transit (LRT) Drivers

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**Abstract.** A cross sectional study was conducted to evaluate whole body vibration (WBV) and back pain problem among light rail transit (LRT) driver. This study was carried out to determine exposure level of whole body vibration and identify back pain problem due to whole body vibration exposure among LRT driver. Standardized Nordic questionnaire was used for the analysis of musculoskeletal symptoms, to identify the prevalence of back pain, information about health history, working time duration, and working experiences was obtained from 52 drivers of light rail transit (LRT) train. HVM 100 Larson Davis was used to measure whole body vibration measurement of eight LRTs with different vehicle number. The measurement of whole body vibration was done during operation working time. The data collected from HVM 100 were transferred to the Blaze software for getting the vibration magnitude of the experiment while data collected from survey were analyzed by using Statistical Package for the Social Sciences (SPSS) for statistical analysis. The analysis of graph patterns and the differentiation of magnitude value from each LRT were studied to determine the exposure level of vibration. A high prevalence of back pain (82.7%) among LRT drivers was found and high daily exposure level was obtained. The finding showed that, there are relations between back pain and daily vibration exposure which resulted in a correlation coefficient of 0.709, with significant at  $\alpha = 0.05$ . In conclusion, it was expected that the individuals subjected to the high vibration levels would tend to report back pain.

### Introduction.

Back pain is one of the common disorders experienced by society, especially for the elderly. It is most common musculoskeletal problem among person 30 to 50 years old [1]. Back pain can occur in many occupations, for a variety of reasons. Some of the risk factors for developing back injury and pain are heavy and/or frequent lifting, static posture (usually seated), unexpected loading of the back, and whole body vibration. Professional drivers are subjected to at least two of these risk factors consistently working in long duration of time, and whole body vibration. Certainly the effects of exposure to these risk factors are felt in these occupations on an individual and industry level, as back aches and pains are considered to be a major cause of illness and sick leave among professional drivers [2]. This study was to determine exposure level of whole body vibration due to back pain problem among LRT driver.

## Literature Review

**Whole body vibration.** Whole body vibration can be describe when the environment is undergoing motion and affect the whole portion of body which is not local to any particular point of contact. It is occurs when the body is supported on a vibrating surface. Whole body vibration refers to where the whole body is exposed to vibration through contact on body by the buttocks or feet [3]. The vibration motion of whole body can be described as a combination of individual motion of six different type of motion which is the translation in three orthogonal direction x, y, and z axes, and rotation around x, y, and z axes [4]. There are three principal possibilities: sitting on a vibrating seat, standing on a vibrating floor, or lying on a vibrating bed [5]. Whole-body vibrations tend to affect the human body which is mainly in vertical vibrations. These vibrations are transmitted to the buttocks and back of the occupant along the vertebral axis via the base and back of the seat [6]. For example a case study by Ana Picu [7] has found that the root means square (r.m.s) of the acceleration value for bus in rage of  $0.213\text{--}1.087\text{m/s}^2$  for the x-axis,  $0.325\text{--}0.968\text{m/s}^2$  for the y-axis and  $0.563\text{--}1.894\text{m/s}^2$  for the z-axis is in the rage of  $0.787\text{--}2.782\text{m/s}^2$ . This prove that the vertical (z-axis) give the largest vibration. The previous study by Ismail et. al (2010) [8] on whole body vibration exposure to train passenger was found that the daily exposure to vibration A(8) from 3 experiment which experiment A are from Kajang to Seremban ( $0.3221\text{ m/s}^2$ ), experiment B from Seremban to Gemas ( $0.2884\text{ m/s}^2$ ), and last is experiment 3 from Seremban to Tampin ( $0.3749\text{ m/s}^2$ ) is under exposure action value ( $0.5\text{m/s}^2$ ). The result can be categorized as safe exposure to passenger body. The daily exposure action value time only required 7 hours 16 min to meet the standardized value of  $0.5\text{ m/s}^2$ . The result founded to exceed the standard time of whole body vibration assessment which is 8 hours is nearly same.

Another study was done by Birlik (2009) [9] on whole body vibration between Suburban train and Intercity train. The daily exposure for 6 hours on suburban train is  $0.3\text{ m/s}^2$  smaller than intercity train which is  $0.52\text{ m/s}^2$  which more than exposure action limit according ISO 2631-1. The suburban train driver travel duration is usually drive take 1 hour 58 minutes. While intercity train drivers drive the train at least take 2 hours and 36 minutes. So the conclusion can be done by this result, the longer exposure time will effect on daily exposure level to vibration.

**Low back pain.** Low back pain is defined as a pain or discomfort in the low back area between the twelfth ribs and the gluteal folds [10]. Low back pain has a consequence for workers in term of suffering of pain, decreased quality of life and disability [11]. Low back pain is a leading cause of morbidity, disability, and lost productivity. Professional driver have a high risk for lumbar spine degeneration, inter-vertebral disc displacement, sciatica, and nonspecific low back pain [2, 12].

A study was done by Birlik (2009) [9] on occupational exposure to whole body vibration of train driver working for State Railway Line. The assessment of the health effect of whole body vibration is usually done by medical interview and Nordic Questionnaire. The result was found out of 12 male suburban train driver (mean age 41, range: 27-50 year; range of employment year: 10-28 year), 6 respondent had low back pain. From 6 respondents, only 2 of the drivers had low back pain claimed that their normal activities are affected due to their complaints but none miss a job day.

Another finding by Back (1991) [13] on back disorder and health problem among subway train operator exposed to whole body vibration was find a higher prevalence than the referents in all aspects of back problem, particularly for cervical and lower back pain. Burdorf, Riel (1997) [14] was found out a complaint of musculoskeletal pain among train drivers. 33 respondents represent 54% of trains driver indicated the present of back pain problem.

## Methodology

The study comprised of a cross-sectional self-assessment questionnaire survey, and measurement of whole body vibration. Information about musculoskeletal problem and exposure to whole body vibration was obtained using Standardized Nordic questionnaire musculoskeletal symptom. The question concerning general information sought detail about physical characteristic, working experience, and daily working duration time. The questions concerning musculoskeletal

health south detail on type of trouble experienced, time off work, and pain duration experienced. Presence or absence of current back pain and/or symptoms in the past 7 days and previous back pain and/or in past 12 months, were also included in the questionnaire.

Vibration of whole body measurement in three orthogonal axes (x, y, and z axis) was performed on a sample of the LRT used by the volunteers during their work. The measurements were done during actual work task and according to the recommendation of the ISO 2631 (1997) standard, at the driver seat interface using a triaxial seat pad accelerometer. The accelerometer was placed on the seat where the driver is sitting on the seat pad and recorded accelerations were acquired over 1 hour per route with same train. For each LRT number, vector sum of the root mean square (rms) of frequency weighted acceleration was calculated.

### Results and Discussion

Table 1 present the personal characteristics summarized data for the respondents. A total of 100 copies of the study questionnaire were sent out for completion and 52 copies were returned.

Table 1: Demographic information among 52 light rail transit drivers

Variable		Frequency	Percentages
Gender	Male	45	86.5
	Female	7	13.5
Ethnic Group	Malay	48	92
	Indian	4	8
Age (year)	21-30 yr	25	48.1
	31-40 yr	23	44.2
	41-50 yr	2	3.8
	51-60 yr	2	3.8
Working Experience (years)	1-5 yr	24	46.2
	6-10 yr	19	36.5
	11-15 yr	5	9.6
	16-20 yr	4	7.7
		<b>Mean</b>	<b>Std. Deviation</b>
Age (year)		32.04	6.23
Duration of Work (hour/Day)		8	0

**Back pain result.** There are 43 respondents represent 82.7% had back pain problem. It shows a high number of respondent having back pain problem because the percentage more than 80%. From 43 respondent having back pain problem, there are consist from 37 male respondents and 6 female respondents. A total 41 respondent having back pain were Malay and only 2 Indian respondents.

Forty four respondents (84.6%) reported previous back pain (pain in past 12 months), which is 38 respondents represent male and 6 is from female respondents. While only 21 from 52 respondents (40.4%) reported current back pain (pain in last 7 days) which is 18 male respondents and 3 female respondents.

**Daily exposure to vibration.** From the analysis conducted for the data obtained from the WBV instrument, Figure 1 shows all LRT have daily exposure value more than exposure limit value ( $1.15 \text{ m/s}^2$ ). The daily exposure limit value is the maximum amount of vibration an employee may be exposed in single day. In this situation the LRT that contain A(8) value more than  $1.15 \text{ m/s}^2$  the employer must take action by reduce exposure to vibration to below the limit value because it may lead to increase health risk to LRT drivers.

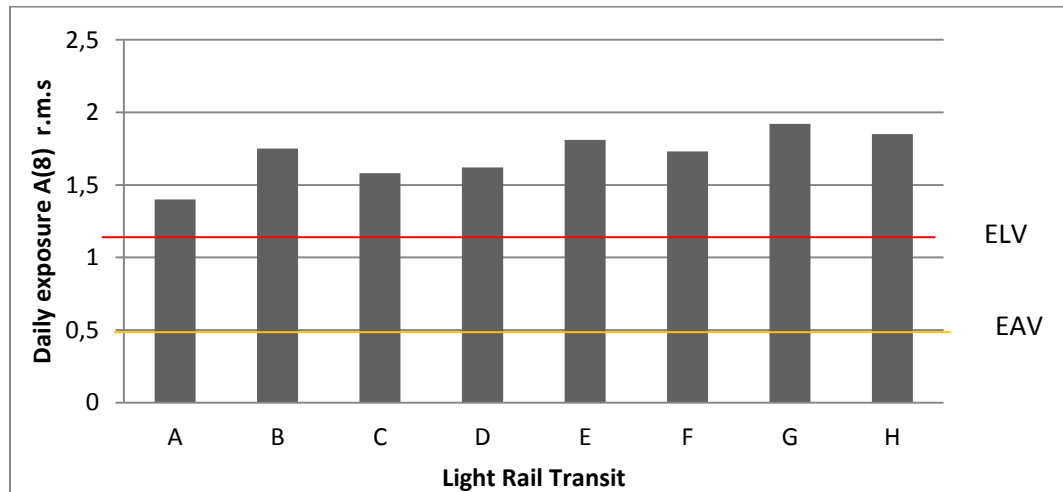


Figure 1: Daily exposure level with different type of LRT

**Relation between back pain with daily exposure vibration value A(8).** The correlation between back pain problem and daily vibration exposure is done is only based on 8 data of respondents during taking whole body vibration measurement. Relation between back pain problem and daily vibration exposure A(8), Pearson correlation give  $0.709^*$ . It shows positive direction which mean there is positive correlation coefficient between back pain problems and A(8) and the strength relationship is strong correlation because it higher than 0.7. The significant (2 –tailed) is the p value of 0.049.

### Conclusion

This study evaluated whole body vibration and back pain problem among LRT driver. In line with the stated aims, the following conclusions are made.

- i. High number of respondent have back pain problem which 43 respondents represent 82.7%.
- ii. All 8 light rail transit contain daily exposure vibration value more than exposure limit value ( $1.15 \text{ m/s}^2$ ).
- iii. Strong correlation between back pain and daily vibration exposure, A(8) which is  $0.709 (> 0.7)$  and significant value  $0.049 (p < 0.05)$ .
- iv. Positive correlation between back pain and daily working hours (working duration time)

### Conclusion remarks

The operating company and the research team from the university and NIOSH are currently conducting further investigations regarding this findings. Necessary action plan will be executed based on the findings and appropriate suggestion and improvement for the benefit of the employees. This study is one of the area that highlighted in National Key Results Area (NKRA) of Malaysian Government for the improvement of public transportation. As the employees (drivers) are taken care of by the management, the ultimate aim of service improvement and safety could be achieved in the future.

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