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Ergonomic Hazards of Low Back Pain among Ambulance Workers in Kelantan, Malaysia

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Low back pain (LBP) is one of the most common occupational health problems affecting the working adult population. The study aimed to identify the ergonomic factors associated with LBP among ambulance workers in emergency departments. This cross-sectional study of 143 ambulance workers was conducted in 10 government hospitals. An English version of the questionnaire, including a Nordic Musculoskeletal Questionnaire and an LBP Risk Factor Questionnaire, was distributed to each respondent. Logistic regression analysis was used to analyse the results. The overall response rate was 85%. The majority of respondents who experienced LBP were aged 30 to 39 years (48.4%), male (69.9%), and of Malay ethnicity (98.5%). Handling difficult-to-grip objects (adjusted odds ratio [OR]: 0.12; 95% confidence interval [CI]: 0.02, 0.55; *p*-value: 0.007) and carrying heavy loads (adjusted OR: 17.44; 95% CI: 2.00, 151.69; *p*-value: 0.010) were associated with the occurrence of LBP among ambulance workers. The results highlighted the potential risks for ambulance workers in terms of carrying difficult-to-grasp and heavy loads. Hence, preventive measures, such as an ergonomic awareness programme, should be undertaken to increase awareness of proper ergonomic techniques in order to reduce the risk of LBP among ambulance workers.

Keywords: Ambulance workers; ergonomic hazards; low back pain; manual handling; Malaysia

I. INTRODUCTION

As an important part of the healthcare system, emergency ambulance services provide prehospital medical emergency services for patients, such as carrying, moving, and transporting patients to an emergency centre, treating them in the ambulance, and conducting cardiopulmonary resuscitation (CPR) (Zhang *et al.,* 2019). A higher rate of musculoskeletal disorders has been reported in ambulance workers than in the general healthcare workforce (Zhang *et al.,* 2019).

Low back pain (LBP) is one of the most common occupational health problems affecting the working adult population. Indeed, approximately 60% to 80% of adults suffer from LBP (both persistent and recurrent) at some time during their lifespans (Waddell *et al.,* 2001). Moreover, a survey among 1356 members of the National Association of Emergency Medical Technicians found that 47% of emergency medical services (EMS) workers suffered from LBP (Dailey, 2006). In the United States (U.S.), there is an alarming rate of injuries among EMS workers. According to the U.S. Department of Labour, the injury rate of EMS workers was higher compared to any other line of work, at 34.6 injuries per 100 full-time workers (Maguire *et al.*, 2005).

Ambulance workers in EMS, like other healthcare providers, are exposed to many occupational hazards due to

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the nature of their occupational tasks in handling patients, quickly loading and unloading them and equipment into an ambulance, selecting medical supplies while the ambulance is moving, along with the physical demands including materials handling, lifting, bending, twisting, whole-body vibration, and long-time standing (Okada *et. al.,* 2005; Dunn & Croft, 2004]. Indeed, due to the work environment of ambulance workers, various medical ailments can affect them. Furthermore, ambulance workers are susceptible to physical disorders that cause LBP not only due to their handling of patients but also from working in abnormal environments, such as at the scene of accidents and natural disasters, as well as in the confined space of the ambulance itself.

LBP among healthcare professionals has been broadly studied, especially among doctors and nurses. However, less attention has been paid to ambulance workers in EMS. This may be the first study to address the issue of ergonomic hazards among ambulance workers in EMS in Malaysia, particularly in the state of Kelantan, located in the northeast of Peninsular Malaysia next to Thailand.

The current study aimed to determine the ergonomic factors associated with LBP among ambulance workers working in emergency departments in Kelantan. Hopefully, the EMS provider, and especially ambulance workers themselves, will understand ergonomic hazards more fully. Measures to reduce the risks can be adopted if ergonomic hazards at work are identified.

II. MATERIALS AND METHODS

A. Study Design and Setting

In 2014, a cross-sectional study was implemented in 10 government hospitals based in Kelantan state, Malaysia: Hospital Universiti Sains Malaysia (USM), Hospital Raja Perempuan Zainab II, Hospital Kuala Krai, Hospital Tanah Merah, Hospital Tumpat, Hospital Pasir Mas, Hospital Tengku Anis, Hospital Machang, Hospital Jeli, and Hospital Gua Musang.

B. Study Population

Ambulance workers involved in EMS, including assistant medical officers (AMOs) and nurses, were included in the study. In Malaysia, occupational groups classified as ambulance workers—as classified under the Technicians and Associate Professionals group, Health Associate Professional subgroup, and The International Standard Classification of Occupation 2008 (ISCO-08)—are AMOs and trained nurses. Those workers who had underlying rheumatic disease or a history of back surgery, trauma, malignancy, or multiple sclerosis, as well as those who did not complete or return the questionnaires, were excluded from the study.

A total of 168 ambulance workers in Kelantan returned the questionnaire. Twenty-five respondents who met one or more of the exclusion criteria were excluded from the study. Thus, the total number of respondents remaining for inclusion in the study was 143.

C. Sample Size Determination

The sample size was calculated using a single proportion formula. Assuming a 95% confidence interval (95% CI) with a 10% margin of error and a prevalence of LBP of 54% (Widanarko *et al.,* 2011), the calculated sample size, *n*, is 96. The total sample size was 110 subjects to allow for a predicted 10% non-response rate.

D. Data Collection

A convenient sampling method was used to collect the data. The data collection process was expedited with the help of one representative (a senior AMO or senior staff nurse) at each of the 10 hospitals. An English version of the self-administered questionnaire was given to each representative, which they distributed to the eligible workers under their supervision. Detailed information about the study was provided on the respondents' information sheet. Each worker was required to sign written informed consent. The corresponding representative then collected the completed questionnaires and submitted them to the researcher.

E. Questionnaire

The paper-based questionnaire consisted of four sections. The first section collected demographic information on individual and work-related data, such as age, gender,

marital status, height, weight, smoking behaviour, physical activity, the job description of either AMO or nurse, and duration of working in EMS. The second part only covered the presence of LBP for a specified period (lifetime, 12 months, and 7-days). This part was adopted from the standardised and validated Nordic Musculoskeletal Questionnaire (NMQ) and was assessed by a 'yes' or 'no' response (Kuorinka *et al.,* 1987).

The third section of the questionnaire explored the ergonomic hazards associated with LBP and was assessed using the LBP Risk Factor Questionnaire (RFQ) developed by Halpern *et al.* (2001). The ergonomic hazards assessment included 17 items: 3 items addressed trunk posture, 7 items assessed handling activities (carrying, pushing, or pulling loads), 3 items covered body position (sitting, kneeling, or climbing), and 4 items assessed environmental exposure (to hazards).

LBP was defined as the presence of any aches, pain, or discomfort in the lower back area with or without the presence of leg pain. A shaded area diagram was also added to enhance the respondents' understanding of the region of back pain.

E. Statistical Analysis

All analyses used the Statistical Package for Social Sciences (SPSS) software, version 22 (SPSS Inc., Chicago, IL, USA). Descriptive analysis was used to describe the individual and work-related details of the respondents. The results were presented as frequency (percentage) for categorical variables and mean (standard deviation [SD]) or median (interquartile range) for numerical variables.

Simple and multiple logistic regression analyses were used to determine the ergonomic factors associated with LBP. Results of the analysis were presented with crude and adjusted odds ratio (OR), along with the 95% confidence interval (CI); $p<0.05$ was considered statistically significant.

F. Ethical Issue

Ethical approval was obtained from the Human Research Ethics Committee, USM, and the Medical and Research and Ethics Committee, Ministry of Health Malaysia.

III. RESULTS

A. Individual and Work-Related Characteristic

Of the 168 returned questionnaires, 25 were disqualified because of unanswered questions; thus, 85% of the responses were valid. Among the 143 valid respondents, 65.0% experienced LBP at least once.

The demographic characteristics of ambulance workers affected by LBP are summarised in Table 1. The mean (SD) age of respondents with LBP was 38.18 (7.03) years, with the 30 to 39 years age group containing the largest proportion of respondents (48.4%). The majority of LBP respondents were male (69.9%) with a body mass index (BMI) of less than 25 (52.7%). Sixty-eight percent of workers with LBP had smoked, and 66.7% were involved in regular sporting or outdoor activity. The majority of respondents with LBP had worked between 5 and 10 years in EMS (38.7%).

Table 1. Demographic characteristics of ambulance workers with LBP (n=143)

Characteristics	**Low Back Pain, n (%)**	
	Yes	**No**
Age (years)*	38.18 (7.03)	35.44 (7.77)
Gender		
Female	28 (30.1)	24 (48.0)
Male	65 (69.9)	26 (52.0)
BMI		
Less than 25	49 (52.7)	22 (44.0)
26 to 29	31 (33.3)	20 (40.0)
More than 30	13 (14.0)	8 (16.0)
Smoking status		
No	64 (68.8)	49 (98.0)
Yes	29 (31.2)	1 (2.0)
Physical activity		
Non-outdoor activity	31 (33.3)	30 (60.0)
Outdoor activity	62 (66.7)	20 (40.0)
Years of service in EMS		
Less than 5 years	26 (28.0)	11 (22.0)

5 to 10 years	36 (38.7)	16 (32.0)
More than 10 years	31 (33.3)	23 (46.0)

*mean (SD); BMI body mass index; EMS emergency medical services

Table 2 summarises the ergonomic factors that influenced LBP among ambulance workers. The majority of ambulance workers with LBP experienced all ergonomic factors, as shown in Table 2.

Table 2. Ergonomic factors influence LBP among ambulance workers (n=143)

Variable		Low Back Pain, n (%)	
		Yes	No
Bends trunk forward slightly with hands above knee level	No	8 (8.6)	2 (4.0)
	Yes	85 (91.4)	48 (96.0)
Bends trunk forward with hands below knee level	No	6 (6.5)	2 (4.0)
	Yes	87 (93.5)	48 (96.0)
Twists trunk and bends sideway	No	16 (17.2)	6 (12.0)
	Yes	77 (82.8)	44 (88.0)
Handles large and bulky objects at arm's length	No	9 (9.7)	3 (6.0)
	Yes	84 (90.3)	47 (94.0)
Carries load with one hand	No	14 (15.1)	6 (12.0)
	Yes	79 (84.9)	44 (88.0)
Handles difficult-to-grip objects	No	23 (24.7)	4 (8.0)
	Yes	70 (75.3)	46 (92.0
Pushes or pulls load	No	6 (6.5)	2 (4.0)
	Yes	87 (93.5)	48 (96.0)
Carries objects weighing 10–30 lb	No	5 (5.4)	5 (10.0)
	Yes	88 (94.6)	45 (90.0)
Carries objects weighing >30 lb	No	14 (15.1)	7 (14.0)
	Yes	79 (84.9)	43 (86.0)
Carries loads weighing >10 lb for >40 ft	No	22 (23.7)	11 (22.0)
	Yes	71 (76.3)	39 (78.0)
Sit	No	7 (7.5)	3 (6.0)
	Yes	86 (92.5)	47 (94.0)
Kneels or squats	No	13 (14.0)	4 (8.0)
	Yes	80 (86.0)	46 (92.0)
Climbs stairs or ladders	No	26 (28.0)	9 (18.0)
	Yes	67 (72.0)	41 (82.0)
Operates powered hand tools	No	19 (20.0)	8 (16.0)
	Yes	74 (80.0)	42 (84.0)
Drives or rides motor-vehicles	No	16 (17.0)	6 (12.0)
	Yes	77 (83.0)	44 (78.0)
Works on slippery or uneven surfaces	No	21 (22.6)	10 (20.0)
	Yes	72 (77.4)	40 (80.0)
Works on elevated surfaces	No	20 (21.5)	9 (18.0)
	Yes	73 (78.5)	41 (82.0)

B. Ergonomic Factors Associated with LBP

The results of the multiple logistic regression in Table 3 indicated that LBP was associated among ambulance workers who handled difficult-to-grip objects (adjusted OR: 0.12; 95% CI: 0.02, 0.55; p=0.007) and carried heavy loads (adjusted OR: 17.44; 95% CI: 2.00, 151.69; p=0.010).

Table 3. Associated factors of LBP among ambulance workers using multiple logistic regression (n=143)

Variables	Multiple Logistic Regression		
	b	Adjusted Odds Ratio (95% CI)	*p*-value
Handling difficult-to-grip objects			
No	-	1.00	-
Yes	-2.16	0.12 (0.02, 0.55)	0.007
Carrying heavy loads			
No	-	1.00	-
Yes	2.86	17.44 (2.00, 151.69)	0.010

b: regression coefficient, CI: confidence interval

IV. DISCUSSION

Most previously published articles from Malaysia indicated that the prevalence of LBP among healthcare professionals was very high and had become a major health concern. However, few studies covering back injuries among ambulance workers in EMS have been published. Moreover, the current study may be the first from Kelantan State to address the issue of ergonomic hazards among ambulance workers in EMS.

Concerning ergonomic factors, manual handling activities associated with work-related LBP, such as handling large objects, handling difficult-to-grip objects, carrying heavy loads, and pushing or pulling loads, were studied among ambulance workers. However, only the handling of difficult-

to-grip objects and carrying heavy loads were statistically significant in relation to LBP.

Ambulance workers who handle difficult-to-grip objects are less likely to have LBP since they already recognise the effect of this ergonomic hazard and take appropriate precautions. Indeed, the handling of difficult-to-grip objects can result in the object slipping and moving unexpectedly (Flanagan & Johansson, 2002). Objects that have an irregular shape and are hard to hold can increase the burden, and workers need an excessive amount of physical effort to hold these objects. Force is needed when workers use their hands to hold and carry objects. Generally, the greater the force required, the greater the degree of risk (Jaffar *et al.,* 2011).

Exerting excessive force on an object may overload the muscles and tendons, thus causing the muscles to contract much harder than normal (Jaffar *et al.,* 2011). This situation can lead to stress on the muscles, tendons, and joints. The amount of force required can sometimes be magnified depending on the activity, thus causing even more muscular fatigue (Jaffar *et al.,* 2011). However, the loads exerted on workers can be reduced if they support objects with handles or gripping aids.

Carrying heavy loads also leads to LBP among ambulance workers. Ambulances are usually equipped with medical supplies, including airway and ventilation equipment, automated external defibrillators, patient transfer equipment, and other medical supplies for emergency responses. These pieces of equipment are often heavy and can place EMS workers at high risk of injury if not carried appropriately.

Carrying loads is much easier and safer when the loads are kept as close to the body as possible. However, to carry a wide load close to the body, the workers need to widen the distance between their arms, and the arm muscles cannot support the load as effectively as when the arms are close together. Therefore, the arm muscles become tired more rapidly when handling a large load. Loads that can only be reached and carried with outstretched arms or by bending or twisting the trunk require more muscular force. The spine may easily be hurt if the trunk is bent or twisted while carrying the load.

However, it was noted that the confidence interval of this variable was wider. This was due to the significant differences in the number of respondents who carried the loads. Out of 143 respondents, only 19% of them did not carry loads with their hands. Even though EMS workers have been trained to utilise proper handling techniques to protect themselves from injury, they may not have sufficient time to perform tasks in the safest manner for their bodies. Furthermore, they must respond quickly when an emergency occurs.

A study reported that lifting wheelchairs from a low level increased the risk of injuries to the workers' lower backs and arms (Ferreira & Stanley, 2005). Injuries also occurred when workers carried wheelchairs on stairs and lifted them into the ambulance (Ferreira & Stanley, 2005). EMS workers often use a bedsheet to lift patients during lateral transfers. This situation may cause friction from sliding and lifting the injured person. Furthermore, lifting patients from the bed to the stretcher or vice versa can increase the load on the back and lead to potential injuries for workers (Lavender *et al.,* 2007).

Bending one's trunk forward was found to be significantly associated with LBP in univariate logistic regression. Specifically, on-duty ambulance workers had to bend their bodies forward while using the stretcher during patient lifting. The arm has to be straight during this procedure, and this increases the risk of injury to ambulance workers. Shorter workers must support approximately 47% of the combined weight of patients and the stretcher (Boocock *et al.,* 2002).

The ergonomic factors identified in the current study were similar to those found in other studies in the literature. Heick *et al.* (2009) reported that LBP could be a result of the cumulative nature of assuming awkward postures when repetitively bending, reaching, or using twisting motions during job tasks (Heick *et al.,* 2009). In addition, ambulance workers have to endure high physical work demands in the ambulance, such as performing short but maximal force exertion activities such as CPR in a fast-moving ambulance and working with awkward postures (Hansen *et al.,* 2012).

The current study had several limitations, including limited data collection. The study only covered the government ambulance service in the hospital; however,

there are other governmental and non-governmental ambulance services operating in the region, such as St John's Ambulance and the Fire and Rescue Department.

V. CONCLUSION

Manual handling activities and awkward posture were significant ergonomic factors associated with LBP among ambulance workers. Work-related LBP may have serious consequences for healthcare professionals, especially workers in emergency services. Thus, the prevention of injury is vital. Establishment of the ergonomic factors that are associated with back pain complaints can lead to better planning and implementation of preventative measures against LBP among ambulance workers. Preventive measures should be taken to reduce the risk of LBP, such as arranging proper rest periods for at-risk workers and developing educational programmes to teach proper body positions when handling patients and heavy objects.

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VII. REFERENCES

Boocock, MG, Gray, MI & Williams, S 2002, 'Patient handling in the ambulance services: case study investigations', Contemporary Ergonomics, pp. 33-38

Dailey, B 2006, 'Musculoskeletal injury prevention. Protect you personnel from on-the-job injury', JEMS: a Journal of Emergency Medical Services, vol. 31, no. 4, pp. 60-64.

Dunn, KM & Croft, PR 2004, 'Epidemiology and natural history of low back pain', European Journal of Physical and Rehabilitation Medicine, vol. 40, no. 1, pp. 9.

Ferreira, J & Stanley, L 2005, Evaluation of manual handling tasks involving the use of carry chairs by UK ambulance personnel, HSE Books.

Flanagan, JR & Johansson, RS 2002, 'Hand movements', Encyclopedia of The Human Brain, vol. 2, pp. 399-414.

Halpern, M, Hiebert, R, Nordin, M, Goldsheyder, DA & Crane, M 2001, 'The test–retest reliability of a new occupational risk factor questionnaire for outcome studies of low back pain', Applied Ergonomics, vol. 32, no. 1, pp. 39-46.

Hansen, CD, Rasmussen, K, Kyed, M, Nielsen, KJ & Andersen, JH 2012, 'Physical and psychosocial work environment factors and their association with health outcomes in Danish ambulance personnel–a cross-sectional study', BMC Public Health, vol. 12, no. 1, pp. 1-13.

Heick, R, Young, T & Peek-Asa, C 2009, 'Occupational injuries among emergency medical service providers in the United States', Journal of Occupational and Environmental Medicine, pp. 963-968.

Jaffar, N, Abdul-Tharim, AH, Mohd-Kamar, IF & Lop, NS 2011, 'A literature review of ergonomics risk factors in construction industry', Procedia Engineering, vol. 20, pp. 89-97.

Kuorinka, I, Jonsson, B, Kilbom, A, Vinterberg, H, Biering-Sørensen, F, Andersson, G & Jørgensen, K 1987, 'Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms', Applied Ergonomics, vol. 18, no. 3, pp. 233-237.

Lavender, SA, Conrad, KM, Reichelt, PA, Gacki-Smith, J & Kohok, AK 2007, 'Designing ergonomic interventions for EMS workers, Part I: transporting patients down the stairs', Applied Ergonomics, vol. 38, no. 1, pp. 71-81.

Maguire, BJ, Hunting, KL, Guidotti, TL & Smith, S 2005, 'Occupational injuries among emergency medical services personnel', Prehospital Emergency Care, vol. 9, no. 4, pp. 405-411.

Okada, N, Ishii, N, Nakata, M & Nakayama, S, 2005, Occupational stress among Japanese emergency medical technicians: Hyogo Prefecture, Prehospital and Disaster Medicine, vol. 20, no. 2 , pp. 115-121.

Waddell, G & Burton, AK 2001, 'Occupational health guidelines for the management of low back pain at work: evidence review', Occupational Medicine, vol. 51, no. 2, pp. 124-135.

Widanarko, B, Legg, S, Stevenson, M, Devereux, J, Eng, A, Cheng, S, Douwes, J, Ellison-Loschmann, L, McLean, D & Pearce, N 2011, 'Prevalence of musculoskeletal symptoms in relation to gender, age, and occupational/industrial group', International Journal of Industrial Ergonomics, vol. 41, no. 5, pp. 561-572.

Zhang, Q, Dong, H, Zhu, C & Liu, G 2019, 'Low back pain in emergency ambulance workers in tertiary hospitals in China and its risk factors among ambulance nurses: a cross-sectional study', BMJ Open, vol. 9, no. 9, p. e029264.