A STUDY ON LOW BACK PAIN AMONG AMBULANCE WORKERS IN THE STATE OF KELANTAN

BY:

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List of Abbreviations

AMO	Assistant Medical Officer
aOR	Adjusted Odd Ratio
BMI	Body Mass Index
CI	95% Confidence Interval
DASS	Depression, Anxiety and Stress Scale
DASS – 21	21-Items Depression, Anxiety and Stress Scale
EMS	Emergency Medical Services
EMT	Emergency Medical Technicians
HR	Hazard Ration
HREC	Human Research Ethics Committee
HUSM	Hospital University Science of Malaysia (Universiti Sains Malaysia)
ILP	International Labour Office
ISCO-08	The International Standardized Classification of Occupations (2008)
LBP	Low Back Pain
MOH	Ministry of Health, Malaysia
MSD	Musculoskeletal Disorder
NMQ	Nordic Musculoskeletal Questionnaire
OR	Odd Ratio
pOR	Pooled Odd Ratio
RFQ	Low Back Pain Risk Factor Questionnaire
SPSS	Statistical Package for Social Sciences
U.S or USA	United State of America
UK	United Kingdom
USM	University Science of Malaysia (Universiti Sains Malaysia)
WHO	World Health Organization

Abstrak

PENGENALAN: Masalah sakit belakang merupakan salah satu masalah utama yang dihadapi oleh kakitangan kesihatan di seluruh dunia amnya, dan petugas-petugas ambulan khususnya disebabkan oleh rutin kerja harian mereka. Namun begitu, kajian berkaitan permasalahan ini dikalangan petugas-petugas ambulan adalah kurang dan tidak menyeluruh.

OBJEKTIF: Objektif kajian ini dilakukan adalah untuk mengenalpasti kadar prevalen masalah sakit belakang di kalangan petugas-petugas ambulan di Negeri Kelantan. Selain dari itu, ianya juga bertujuan untuk mengenalpasti faktor-faktor yang berkaitan dengan permasalah tersebut.

TATACARA KAJIAN: Borang soalselidik telah diedarkan kepada semua petugas-petugas ambulan yang bertugas di satu hospital universiti (Universiti Sains Malaysia) dan juga sembilan (9) hospital kerajaan di Negeri Kelantan. Soalan ini telah menggunapakai tiga (3) siri soalselidik yang telah digunapakai sebelum ini, iaitu *Nordic Musculoskeletal Questionnaire* (NMQ), *Low Back Pain Risk Factor Questionnaire* (RFQ) dan juga *21-item Depression, Anxiety and Stress Score* (DASS-21). Sejumlah 143 set soalan yang lengkap dan memenuhi kriteria-kriteria yang ditetapkan telah dimasukkan ke dalam kajian ini. Analisa statistik telah dilakukan dengan menggunakan *Chi-square test, Fisher's Exact test* dan juga *Mann-Whitney test.*

KEPUTUSAN: Kadar prevalen sakit belakang dikalangan petugas-petugas ambulan di Negeri Kelantan adalah 65.0% (CI: 57.1 – 72.9). Antara faktor yang dikenalpasti berkait-rapat dengan masalah sakit belakang adalah jantina lelaki (*p value*: 0.035), merokok (*p value*: 0.001) dan juga keterlibatan dengan aktiviti-aktiviti fizikal ('*out-door*') (*p value*: 0.001). Manakala perbuatan membawa barang yang berat dengan menggunakan sebelah tangan juga dikenalpasti sebagai salah satu faktor yang boleh menyebabkan sakit pingang (*p value*: 0.024). Kajian ini juga menunjukkan bahawa ketiga-tiga simptom psikologi yang dikaji, iaitu kemurungan (depression), cemas (anxiety) dan tertekan (stress) tidak berkait-rapat dengan permasalahan sakit belakang (*p value*: > 0.05).

KESIMPULAN: Kajian ini telah menunjukkan bahawa kadar prevalen masalah sakit belakang di kalangan petugas-petugas ambulan di Negeri Kelantan adalah tinggi. Kajian ini juga telah berjaya mengenalpasti beberapa faktor risiko yang berkait-rapat dengan permasalah sakit belakang. Namun begitu, kajian yang melibatkan lebih ramai peserta perlu dilakukan pada masa hadapan bagi mengkaji secara lebih mendalam dari segi kesan dan impak permasalahan sakit belakang ini dikalangan petugas ambulan.

Abstract

INTRODUCTION: Low back pain (LBP) is one of the major musculoskeletal disorders (MSDs) faced by health care workers worldwide, resulting in serious social and economic impact. Among them, the ambulance workers are particularly at risk of developing LBP, due to their nature of work. However, only a few research were conducted in the past to study the problem of LBP among the ambulance workers.

OBJECTIVES: The purposes of this study are to describe the prevalence and associated factors of LBP among ambulance workers in the state of Kelantan.

METHODOLOGY: A self-administered questionnaire regarding LBP was distributed to all ambulance workers working in a university hospital (Universiti Sains Malaysia) and nine (9) government hospitals in the state of Kelantan. The questionnaire adopted and integrated three existing questionnaires, which are the Nordic Musculoskeletal Questionnaire (NMQ), Low Back Pain Risk Factor Questionnaire (RFQ) and 21-items Depression, Anxiety and Stress Score (DASS-21). A total of 143 completed questionnaires fulfilled the inclusion and exclusion criteria were included in the study. Statistical analysis was carried out with Chi-square test, Fisher's Exact test and Mann-Whitney test.

RESULTS: The lifetime prevalence of LBP among ambulance workers in the state of Kelantan is 65.0% (Confidence Interval, CI 57.1 – 72.9). LBP was associated with male gender (p value: 0.035), smoking (p value: 0.001) and involvement in out-door activities (p value: 0.001). Carrying load with one hand is the only work-related ergonomic hazard associated with LBP (p value: 0.024). The negative psychological affects studied; depression, anxiety and stress are not associated with LBP (p value > 0.05).

CONCLUSIONS: This study confirmed the high prevalence of LBP among the ambulance workers. It also identified several factors that are associated with the development of LBP among this particular group of health workers. However, larger studies need to be carried out to properly understand the magnitude and impacts of LBP and other MSD among this profession.

1. INTRODUCTION

1.1. Overview

Low-back pain (LBP) is a common musculoskeletal disorder in general and working population worldwide (Widanarko *et al.*, 2011). About 80% of the world's population will develop low-back pain at some time in their life (Freburger *et al.*, 2009). It was estimated that, on any given day, about 10 million people are experiencing LBP worldwide (Loney and Stratford, 1999). Most low-back pain episodes are mild and rarely disabling. Nevertheless, relapses are common and individuals with long-standing low-back pain tend to shows a more persistent course (Hestbaek *et al.*, 2003; Cassidy *et al.*, 2005; Dunn *et al.*, 2013). This may result in serious social and economic impacts on individual and communities (Buckle and Jason Devereux, 2002; Ng *et al.*, 2014).

LBP affected some of the occupational groups more than other (Punnett and Wegman, 2004; Myers *et al.*, 2007). High-risk occupations included those people working in medical facilities, air transportation, mining and manufacturing. Sport, housewife and systemic diseases, in the other hand, are among the non-occupational related risk factors (Punnett and Wegman, 2004). Professional drivers were noted to have highest recurrent rate of LBP (42.1%), whereas among the recurrent cases, nurses had the highest average number of recurrences (2.03) (Abenhaim *et al.*, 1988).

It remains as one of the main occupational hazards among healthcare workers. A number of studies conducted in the Western world proved that the prevalence of LBP is indeed high in this working group (Studnek and Crawford, 2007; Simon *et al.*, 2008; Roffey *et al.*, 2010; Studnek *et al.*, 2010).

The problem was extensively studied among nurses and doctors, however relatively less attention has been paid to the ambulance workers. Nevertheless, the problem of LBP among this particular group of has been addressed more than 30 years ago. In one of the ambulance service in UK, it was reported that an average of 27 ambulance workers suffered back pain every year, between 1968 – 72 (Leyshon and Francis, 1975). Subsequent studies on LBP among ambulance workers managed to demonstrate that back injuries are common Musculoskeletal Disorders (MSD) among this working population. (Hogya and Ellis, 1990; Tam and Yeung, 2006; Studnek and Crawford, 2007; Studnek *et al.*, 2010).

The fact that there is lack of study on this matter among ambulance workers resulted in this current study. This study attempts to address the issue of LBP among ambulance workers in the Malaysia, especially in the state of Kelantan. Hopefully it may help in further understanding of the magnitude and impact of MSD, particularly LBP among the front-liners of medical services – the ambulance workers.

1.2. Objective

1.2.1. General Objective

To study the prevalence and factors associated with low-back pain among ambulance workers involved in the Emergency Medical Services (EMS) in Kelantan.

1.2.2. Specific Objectives

    (1)   To determine the prevalence of low-back pain among ambulance workers involved in EMS in Kelantan.

    (2)   To determine the associated factors for low-back pain among ambulance workers involved in EMS in Kelantan.

2. LITERATURE REVIEW

2.1. Epidemiology

Musculoskeletal disorders (MSDs) are widespread globally, experienced by majority of people worldwide, especially in the working-age population. MSDs are recognized as one of the major cause of long-term sick leaves and early retirement (Pattani *et al.*, 2001). Although not absolutely caused by work, they are the single largest category of work-related illness in many countries (Punnett and Wegman, 2004).

Among the MSDs, the prevalence was highest for low-back, neck and shoulder pain (Widanarko *et al.*, 2011). The Global Burden of Diseases, Injuries, and Risk Factors Study 2010 (GBD 2010) showed that LBP was the top 6 cause of disability globally and the leading cause of disability in Western Europe and Australasia, in 2010. The same study also showed that, it was ranked at the third place, after Ischemic Heart Disease (IHD) and Cerebrovascular Disease as the leading causes of disability, in the non-communicable disease group (Murray *et al.*, 2012).

Various workplace studies had revealed that LBP was also prevalent in Malaysia. A study of LBP among commercial drivers in peninsular Malaysia showed that the prevalence of LBP was 60.4% (Tamrin *et al.*, 2007). In another study, looking at the relation between LBP and whole body vibration among Malaysia's military armored vehicle drivers, the 12-months prevalence of low back problem was 73.6% (Rozali *et al.*, 2009). Recent study showed that the 1-month prevalence of LBP among 513 railway workers in Malaysia was 69% (Ganasegeran *et al.*, 2014). A data obtained from the National Medical Care Statistic for Primary Care in 2012, published

by the Ministry of Health, Malaysia (MOH) revealed that LBP contributed to nearly 25% of the total MSD diagnosed by both public and private primary clinics in Malaysia (Sivasampu S, 2014).

LBP was associated with major economical and health implication, with no effective cure (Blyth *et al.*, 2003; van Middelkoop *et al.*, 2011; Hong *et al.*, 2013). The problem, if not properly managed, will result in poorer prognosis and may affect the functional health, long after retirement (Campbell *et al.*, 2013; Sabbath *et al.*, 2013).

Inconsistency in the definition and classification of LBP leads to a difficulty in describing the epidemiology of LBP. Nevertheless, numerous studies has shown that LBP was a major health problem worldwide, with a life-time prevalence as high as 86% (Ozdemir *et al.*, 2013). The number of individual with LBP is expected to increase significantly over the next decades, as the world population ages (Hoy *et al.*, 2012).   The prevalence of recurrence episode of LBP was also high; however the presence of heterogeneity in the measurement tools used hampers comparisons of figures between those studies (de Vet *et al.*, 2002; Wasiak *et al.*, 2009; Cifuentes *et al.*, 2011).

LBP was prevalent in industrialized and non-industrialized countries alike. LBP was identified as one of the commonest reason for physician visit and hospitalization in the USA, with high medical cost care (Parthan *et al.*, 2006). Whereas in North Staffordshire, UK, a study involving 935 subjects of 30-59 years old showed that almost 13% were unemployed as a result of LBP. Among the employed subjects, 22% were reporting sick leave and 11% were on light-duties due to LBP (Wynne-Jones *et al.*, 2008). In another study,

the 6-months prevalence of LBP among 674 adult population in a Mediterranean country was 39.5% (Korovessis *et al.*, 2012). Among adult population in the Australia, a point-, 12-month- and lifetime prevalence of LBP was 25.6% (CI 23.6 – 27.5), 67.6% (CI 65.5 – 69.7) and 79.2% (CI 77.3 – 81.0), respectively (Walker *et al.*, 2004). In Japan, 25.2% of 20 044 respondents involved in a pain-associated cross-sectional epidemiological survey reported LBP, and 13.5 % of them reported LBP as their primary pain (Yamada *et al.*, 2013).

Meanwhile, in a study among farmers in South-West Nigeria, the 12-month prevalence of LBP among 604 subjects was 74.4% and almost 66% of them were unable to continue some of the previously enjoyed activities (Tella *et al.*, 2013). In Nepal, another developing county, the 1-month period prevalent of LBP among 938 textile workers involved in a cross-sectional study was 35% (Paudyal *et al.*, 2013).

The prevalence of LBP was comparatively high, both in administrative working groups and blue-collar workers. LBP, together with fatigue and upper respiratory symptoms were the commonest complaints in both working group (Schreuder *et al.*, 2008). A telephone interview of 3003 subjects randomly selected from the New Zealand Electoral Roll in 2010 showed that the 12-months period prevalence of LBP was 52% and 57% for white- and blue-collar workers, respectively (Widanarko *et al.*, 2011). Recently, a study among male employee in a package producing industry revealed similar finding, whereby the prevalence of LBP was 51.6% in white-collar workers and 55.9% in blue-collar workers (Yildirim *et al.*, 2014). Another study, looking at the impact of pain in different region of the body on long-term

sickness absence among Danish workers showed that the prevalence of severe LBP was 25% for administrative group and 33% for labor group (Andersen *et al.*, 2011).

The LBP and other MSDs among health care workers, particularly in nurses, has been addressed in many studies. Among nurses, the prevalence of disability from LBP and neck-pain were high in those working in hospitals, compared to nursing home and home care (Simon *et al.*, 2008). In a study involving hospital staff in Tunisia, musculoskeletal symptoms were commonly encountered, with a prevalence rate of 74.5% for LBP, followed by neck pain, 38.1% and knee pain, 31.1% (Jellad *et al.*, 2013). Similarly, in Yemen, the 12-month prevalence of LBP among female nurses was 59.8% (Ghilan *et al.*, 2013). The lifetime prevalence of LBP among nurses in Taiwan was 82.0%, with a point prevalence of 43.78% (Lin *et al.*, 2012). In Malaysia, the prevalence of LBP among nurses working in government clinics and hospital in one of the district in the central region of Peninsular Malaysia was 79.4% (Rahmah *et al.*, 2008).

Beside nurses, other medical professions at risk of developing LBP are ambulance personnel. Treating and transporting injured and sick patients, 24 hours a day, 7 days a week exposed the ambulance workers to various occupational hazards, from a simple muscle sprain to assault and fatal motor-vehicular crash (Klontz *et al.*, 1991; Boal *et al.*, 2010; Maguire, 2011; Reichard *et al.*, 2011). A data from the U.S. Department of Labor showed that, between 2003 and 2007, paramedics and EMTs had an injury rate 3 times higher than national average, in which 43% of them suffered from back injury. The most common event leading to the injuries were

overexertion (56%), falls (10%) and transportation-related (9%). A total of 530 assaulted cases were reported, whereby 45% involved female paramedics and EMTs (Maguire and Smith, 2013).

As part of their daily job, ambulance workers are required to lift or carry patients and cannot always use the ideal methods of lifting due to the circumstances faced at that particular time; over-weight patients, narrow stairs or slippery surface. They also need to attend to patient or performing cardio-pulmonary resuscitation while in a limited and constraint patient-compartment of a moving ambulance (Yusuff *et al.*, 2013). These tasks put localized strained on the back (Jones and Lee, 2005).

In an analysis of a sub-population enrolled in the Longitudinal EMT Attributes and Demographics Study (LEADS), more than half (50.5%) of the emergency medical services personnel experienced back pain (Studnek *et al.*, 2010). Locally, one (1) ergonomic study reported that 89% of paramedics had LBP as a result of working in patient-compartment of an ambulance (Yusuff *et al.*, 2013).

The biodynamic of low back injury among healthcare workers as a result of manual lifting and recurrent loads was described by a conceptual model by Lloyd (Llyod, 2003) (Figure 2.1).
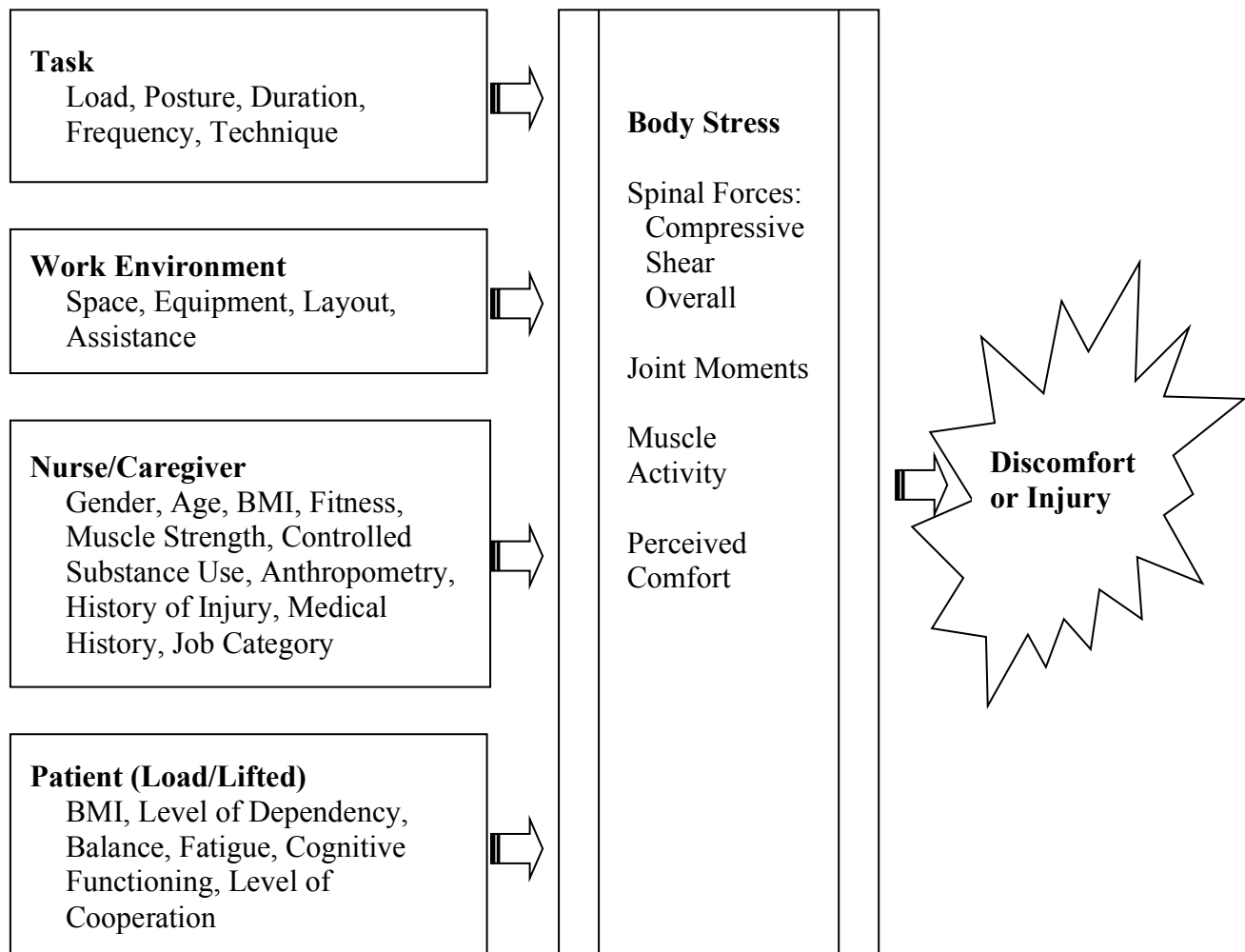
Figure 2.1: Conceptual model of injury risk characteristics. (Reproduced from Lloyd, 2003).

2.2. Definition

2.2.1. Low Back Pain

Vrbanic (2011) defined LBP as a pain and discomfort that was localized below the costal margin and above the inferior gluteal fold, with or without the presence of leg pain (Vrbanic, 2011). The same definition was used by Gavira Pavon *et al.* in a study of LBP-related urinary incontinence (Gavira Pavon *et al.*, 2013). This definition is in agreement with one of the earlier definition proposed by Frank *et al.* in 1996, which defined it as any pain between the ribs and the top of the leg, from any cause (Frank *et al.*, 1996).

Kourinka *et al.* (1987) used similar definition in developing a well-known Nordic Musculoskeletal Questionnaire (NMQ). However, in the questionnaire, a diagram with shaded area to define the low back and other body regions was included to improve the understanding of the definition (Figure 2.2) (Kuorinka *et al.*, 1987).

Other definition of LBP was a lumbar, sacral or lumbosacral spinal pain (Malliou *et al.*, 2006). LBP was also considered for a pain that localized to the paraspinal regions, spreading to the flanks and into the buttocks (Devereaux, 2009). Variation in the definition of LBP reflected difficulties faced to make a specific anatomical diagnosis of LBP, owing to the complexity of the muscular, ligament, bony as well as neural elements of the back (Hicks *et al.*, 2002).

NECK

SHOULDERS

UPPER BACK

ELBOWS

LOW BACK

WRISTS/HANDS

HIPS/THIGHS

KNEES

ANKLES/FEET
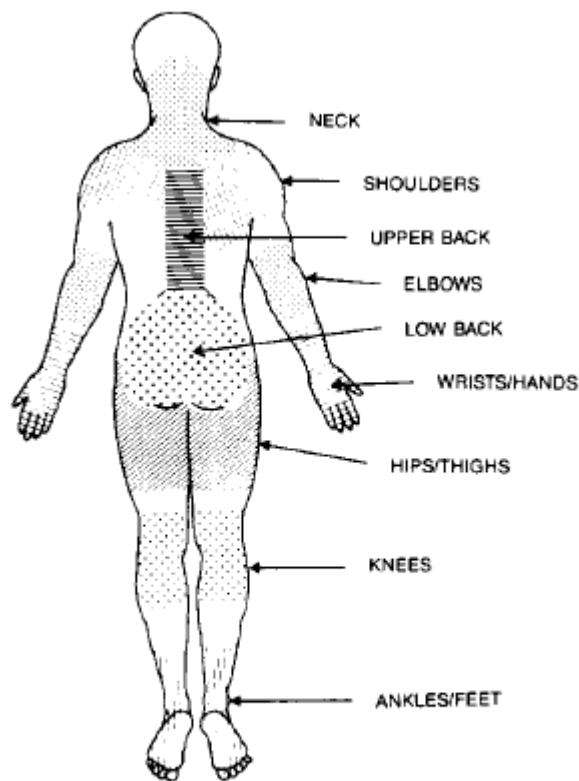
In this picture you can see the approximate position of the parts of the body referred to in the questionnaire. Limits are not sharply defined, and certain parts overlap. You should decide for yourself in which part you have or have had your trouble (if any).

Figure 2.2: A diagram with shaded area used in Standardized Nordic Questionnaire for analysis of musculoskeletal symptoms (Kuorinka *et al.*, 1987).

Many recent studies showed that LBP is a chronic condition with episodes of recurrence and remission (Itz *et al.*, 2013; Young *et al.*, 2013). Episode of LBP is defined as a pain lasting more than 24 hours, preceded and followed by at least 1 month of pain-free (de Vet *et al.*, 2002). Researchers were divided in defining acute LBP. Previously, some authors defined an acute LBP if the symptom of LBP lasted for 14 days and less (Kovacs *et al.*, 2005; Heitz *et al.*, 2009). Contradicted with the other authors, Scott Kinkade, in his paper 'Evaluation and Treatment of Acute Low Back Pain', had defined an acute LBP as any pain lasted less than six weeks

(Kinkade, 2007). His argument was that, existing studies had showed that up to 90 percent of the cases of LBP recover in six weeks time (Deyo and Weinstein, 2001; Carragee and Hannibal, 2004). Therefore, in his opinion, any LBP with no any evidence indicating a serious underlying condition such as fracture, infection or malignancy should be treated conservatively and was not indicated for any imaging assessment. Recently any pain that persists between six to 12 weeks still being considered as an acute event, often non-specific and self-limited (Casazza, 2012). Chronic LBP was established when the symptom of pain persist for 3 months or more (Carey *et al.*, 1999; Blyth *et al.*, 2003; Diamond and Borenstein, 2006; Rozenberg, 2008; Gautschi *et al.*, 2009; Heitz *et al.*, 2009; Fujii and Matsudaira, 2013).

Researchers also differ in defining the severity of LBP. One study divided the LBP into low- and high-impact LBP, with duration of 1-week is taken to distinguish between the groups (Santos-Eggimann *et al.*, 2000). A recent study classify the severity of LBP based on the radiation of pain, in which LBP without radiation was considered as mild cases and LBP with radiation above and below the knee as moderate and severe LBP, respectively (Murtezani *et al.*, 2011).

The definition of LBP used in the current study was similar to the definition used by Kourinka *et al.* (1987), Gavira Pavon *et al.* (2013) and Vrbanic (2011). The NMQ was used in the study to help defining the area of LBP. The definition was chosen since it was accepted by most of the earlier researchers. Furthermore, the NMQ was used as a part of this study's questionnaire.

2.2.2. Ambulance Workers

Ambulance workers are personnel that provide emergency health care to patients who are injured, sick, infirm, or otherwise physically or mentally impaired prior to and during transport to medical, rehabilitation and other health care facilities. They were classified under the Technicians and Associate Professionals group, Health Associate Professionals subgroup, in The International Standard Classification of Occupations, revised 2008 (ISCO-08) (ILO, 2012). The occupations included in this group, among others, are emergency paramedics and emergency medical technicians (EMTs). They received formal training in emergency medical treatment, patient transport, ambulance principles and practice, or related field (WHO, 2010).

In Malaysia, occupational group included under the ambulance worker category, as defined by the ISCO-08, are Assistant Medical Officers (AMO) and Trained Nurses. According to a regulation governed by the MOH, a minimal requirement of diploma in Assistant Medical Officer or Nursing, is required for anybody to practice these 2 professions in Malaysia (KKM, 2011a; KKM, 2011b).

2.3. Functional Anatomy

2.3.1. Lumbar Vertebral Column

Human lumbar vertebral column consists of five separate, irregularly shaped vertebrae (Figure 2.3). Each lumbar vertebral may be divided into three functional components - vertebral body, the pedicles and the posterior elements (Figure 2.4). Together, these three elements contributed to the integrated function of the whole vertebra. Vertebral body is a short, box-shape bone with a flat superior and inferior surface (Figure 2.4). Each vertebral body is made up of a cancellous bone surrounded by a shell of cortical bone. These features give a light but strong structure that subserves the weight-bearing function of the vertebrae. The posterior elements are irregular mass of bones, consists of the laminae, the superior articular processes, the inferior articular processes, the transverse processes, the accessory processes, the mammillary processes and the spinous process (Figure 2.5). The inferior articular processes of a superior vertebral body locked with the superior articular processes of an inferior vertebral body, forming an apophyseal joint. This synovial joint prevents twisting and forward sliding of the vertebral bodies. The transverse, accessory, mammillary and spinous processes act as areas of muscle attachments whereas the longer transverse and spinous processes act as levers that enhanced the action of muscles that attached to them. The laminae transmit any forces applied to the inferior articular processes or the spinous process to the vertebral body, to execute movement or provide stability. The pedicle connects the vertebral body to the posterior elements. It transmits both tension and bending forces

exerted by muscular actions at the posterior elements to the vertebral body (Bogduk, 2012).

Adjacent vertebrae bodies are separated by a 5 – 10 mm height fibrocartilage pad, called intervertebral disc (Adams, 2013) (Figure 2.3). The intervertebral discs provide small bending, twisting and sliding movements between the vertebrae. They also dissipate vertical forces evenly on the vertebral bodies (Adams *et al.*, 1996). The discs comprise of 15 to 25 tough concentric layers (lamellae) of annulus fibrosus, surrounding a deformable and soft nucleus pulposus (Figure 2.6). Each lamella consists of 20 to 60 separate bundles of collagen fibers. Type I collagen fibers made up the most of the annulus, reinforce by some amount of collagen type III and IV. Fibers of the inner annulus curve around the nucleus pulposus and gradually blend in with the hyaline cartilage of the endplate. At the outer layer, the fibers are strongly embedded in the adjacent vertebrae body. The nucleus pulposus consists mainly of proteoglycan, which is reinforced by fibrous protein. Each proteoglycan molecules made up of more than 80% tissue water (Frank M. Phillips, 2010). Another important component of the intervertebral discs is layers of hyaline cartilage that cover the superior and inferior aspect of the disc, named endplate (Figure 2.6). Each endplate cover almost the entire surface of the adjacent vertebral body, binding the intervertebral disc to it respective vertebral body. A ring apophysis is a narrow rim of bone around the perimeter of the vertebral body, not covered by the endplate (Adams, 2013).
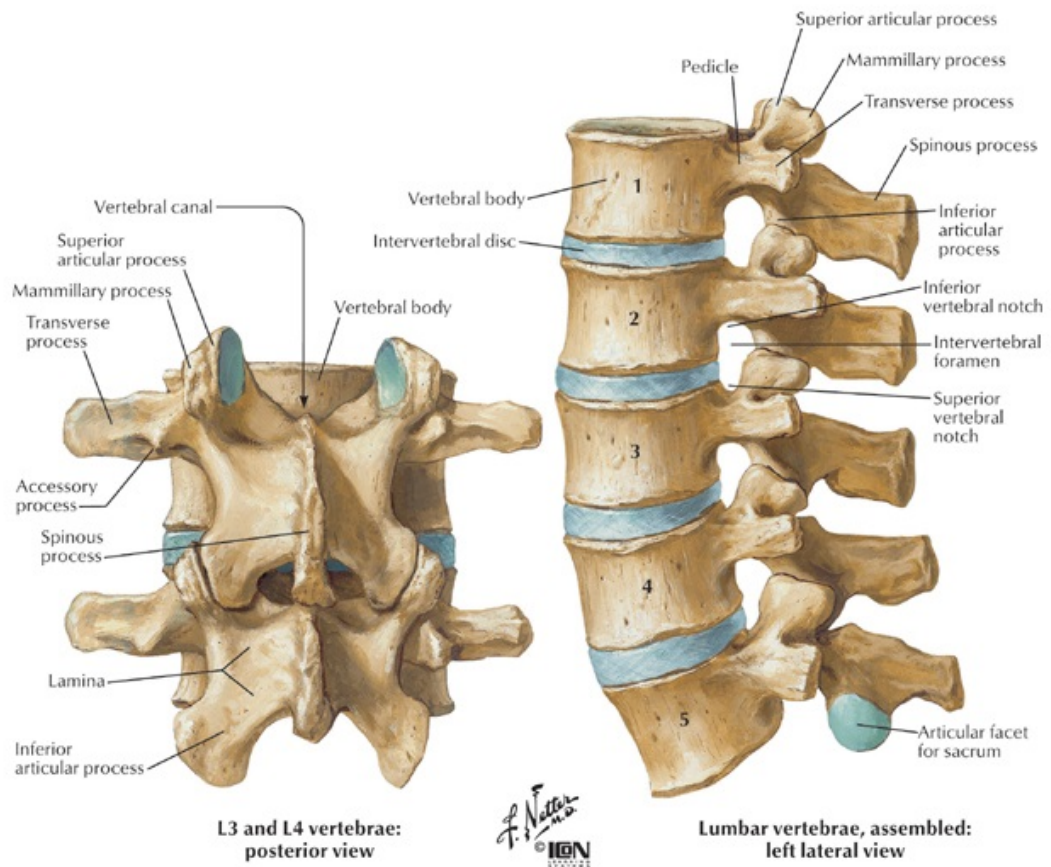
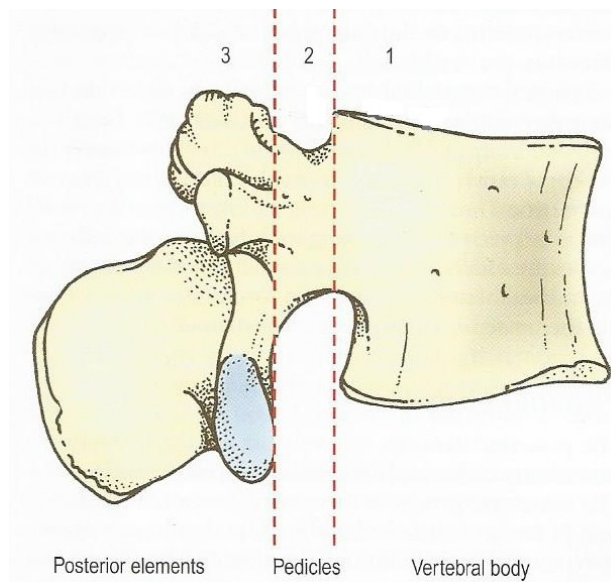**Figure 2.3:** Lumbar vertebra. (Reproduced from Netter, 2010).

Figure 2.4: The division of a lumbar vertebra into its three functional components. (Reproduced from Bogduk, 2012).
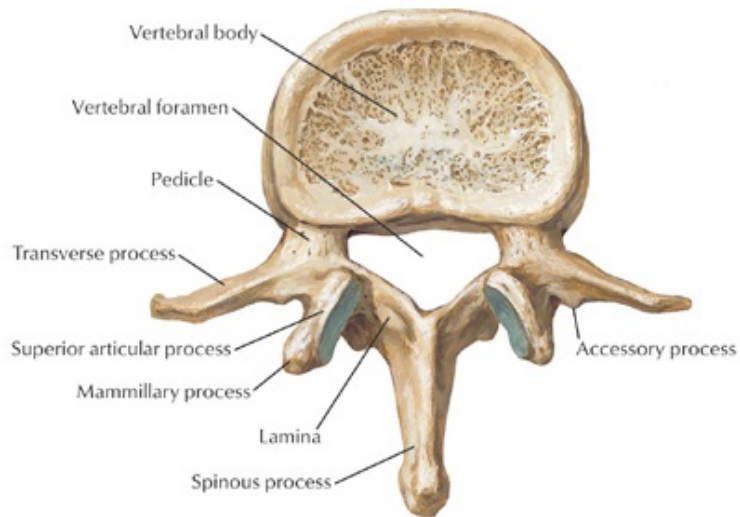
Figure 2.5: Parts of a lumbar vertebra (superior view). (Reproduced from Netter, 2010).
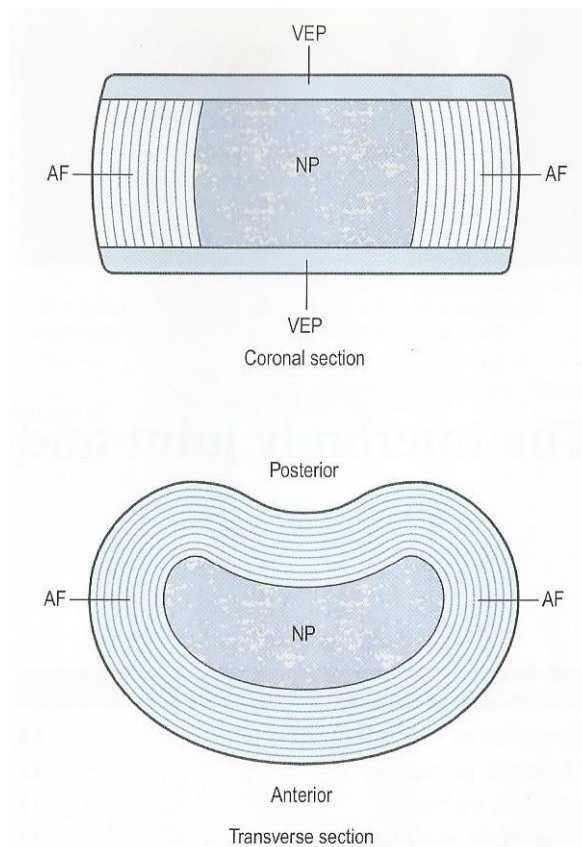

Figure 2.6: A basic structure of a lumbar intervertebral disc. AF, annulus fibrosus; NP, nucleus pulposus; VEP, vertebral endplates. (Reproduced from Bogduk, 2012).

2.3.2. Spinal Stability

Spine stability is defined as the ability of the spinal column or its components to resist buckling when undergoing load. It is maintained by means of three subsystem namely the central nervous system, osteoligamentous system and muscle subsystem (Panjabi, 1992) (Figure 2.7).
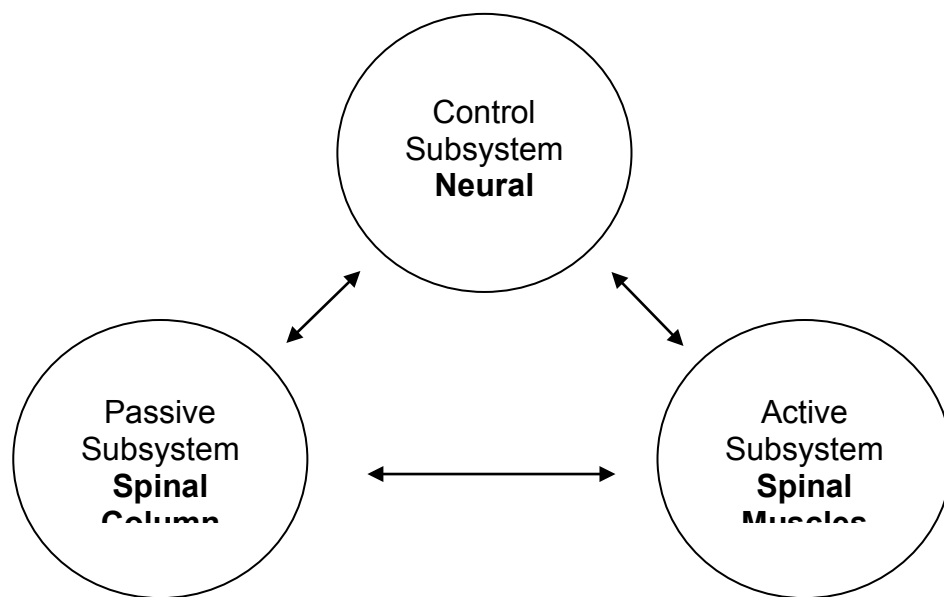
Figure 2.7: The spine stability system. (Reproduced from Panjabi, 1992).

When viewed from lateral, an upright normal lumbar vertebral curved posteriorly. Such arrangement resulted in the L1 vertebra to lie vertically above the sacrum. This posterior concavity of the lumbar vertebrae is called lumbar lordosis (Figure 2.8). Several factors contribute to this normal concavity. The first of this is the wedge-shaped of L4/5 intervertebral disc, whereby its posterior height is 6 – 7 mm shorter than the anterior part.

Secondly, the L5 vertebral body is also wedge-shaped; due to its posterior surface is about 3mm less than the anterior surface. The third factor is slight backward inclination of each vertebra above L5, in relation to vertebra below.
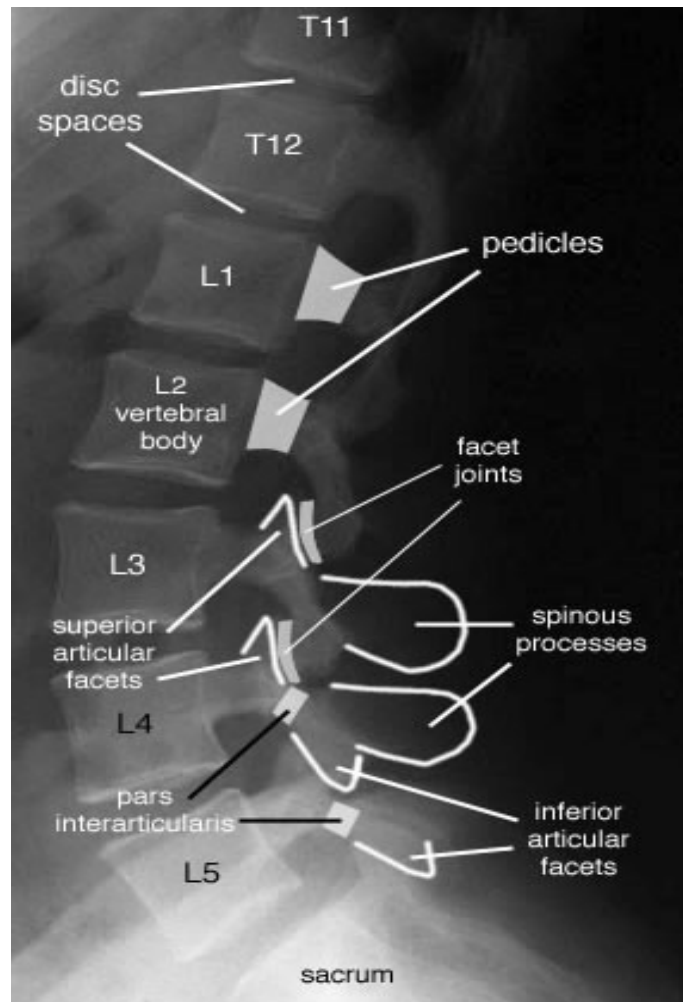

Figure: 2.8: A lumbar X-ray showing normal lumbar lordosis. (Reproduced from Sullivan, 2003).

The presence of lumbar lordosis allowed a proper articulation between L5 and the upper part of the sacrum, which is inclined forwards and downwards. There is a tendency for L4 to slip forwards on L5, and for L5 to slip forwards on the sacrum due to the anterior tilting of the sacrum. This

forward displacement is resisted by a locking mechanism of each apophyseal joint, especially of L4/L5 and L5/S1, as well as by ligamentous support provided, particularly, by iliolumbar ligament, anterior longitudinal ligament and anterior half of annulus fibrosus. (Middleditch and Oliver, 2005).

Muscles surrounding the lumbar spine can be divided into 3 groups – (i) psoas major muscle, (ii) intertransversarii laterals and quadratus lumborum, as well as (iii) the lumbar back muscles. Out of these three groups, the lumbar back muscles played some role in providing stability to the lumbar spine. This muscle group lies behind and covers the posterior elements of the lumbar spine. The muscles in this group serve to correct any possible displacement by gravity or by asymmetrical weight bearing. The appropriate muscles will be recruited depending on the direction of any displacement. Morphologically, the lumbar back muscles can be further divided into three subgroups. The first subgroup is the short intersegmental muscles, consists of the interspinales and the intertransversarii mediales. The multifidus and the lumbar components of the longissimus and iliocostalis represent the second subgroup - the polysegmental muscles, that attach to the lumbar spines. The third subgroup - the long polysegmental muscles group, extend from thoracic levels to their attachments on the ilium and sacrum. This group of muscles, represented by the thoracic component of the longissimus and iliocostalis lumborum, do not attach to the lumbar vertebrae (Bogduk, 2012).

2.4. Sources of LBP

As LBP is a somatic type of pain, virtually, any structures located at the low back region and innervated by a nerve supply can be a possible source of the pain. Nonetheless, reliable evidences to implicate any of the structures are still lacking, resulting in uncertainty and controversies (Bogduk, 2012). The possible causes of occupational related LBP are summarized in the Table 2.1 (Rampal *et al.*, 2007; Bogduk, 2012).

Table 2.1: Differential Diagnosis of Occupational Related LBP

Bone and Joint
    Vertebral body
        Fracture
    Posterior elements
        Fracture
        Spondylolysis
        Kissing spines (Baastrup's Disease)
        Lamina impaction
Intervertebral Discs
    Annulus Fibrosus
        Herniation
        Torsion injury
    Nucleus Pulposus
        Internal Disc Disruption (IDD)
    End Plates
        Fracture
        Avulsion
        Schmorl's node formation
Ligaments and Muscles
    Interspinous ligaments sprain
    Iliac Crest Syndrome
    Muscle sprain
    Muscle spasm

2.5. Risk Factors

Risk factors for LBP are multidimensional. While several risk factors had been identified, the evidence for some others is still insufficient or contradictory. Generally, these factors can be broadly divided into individual and occupational risk factors (Skovron, 1992; Jellad *et al.*, 2013).

2.5.1. Individual Risk Factors

Individual risk factors frequently implicated for the development of LBP included older age, female sex, high body mass index (BMI), being married and unhealthy life-style (Levin *et al.*, 2001; Devereaux, 2009).

2.5.1 (a)   Age

LBP, for sometimes, is believed to be a problem of the elderly. A systemic review of 165 articles on the global prevalence of LBP found out that the prevalence of LBP was highest among people aged 40 – 80 years old (Hoy *et al.*, 2012). Another systemic review looking at the pattern of LBP prevalence with age revealed that the prevalence of benign form of LBP exhibit curvilinear association with age, whereas the prevalence of the severe form increases with age (Dionne *et al.*, 2006). A cross-sectional study of nearly 30,000 subjects aged 16 years old and older in Spain revealed that LBP was 1.5 times (CI 1.3 – 1.8) higher among subjects in the 31 – 50 years age group, compared to those in 16 – 30 years group (Fernandez-de-las-Penas *et al.*, 2011). However, interestingly, children and adolescent were also equally at risk of developing LBP. A recent meta-analysis study on prevalence rates of LBP in children and adolescence of 18 years old and

younger, revealed a mean lifetime prevalence of 0.399 (CI: 0.342 – 0.459) (Calvo-Munoz *et al.*, 2013).

2.5.1 (b)   Gender

Researchers found contradicting data regarding the gender factor toward the development of LBP. A recent retrospective study showed that men between 18 and 34 years old were 1.18 times more risk of getting LBP (Beaudet *et al.*, 2013). However, few other studies indicated that female were at higher risk of developing LBP, regardless of the age-group (Widanarko *et al.*, 2011; Cho *et al.*, 2012; Jimenez-Sanchez *et al.*, 2012; Bener *et al.*, 2013; Paudyal *et al.*, 2013). A study conducted on undergraduate medical students in Delhi, India showed that the prevalence among males and females was 45.3% and 50% respectively (Aggarwal *et al.*, 2013). A study on subjects aged 70 years and older showed that female sex was independently associated with likelihood of suffering from a short-term restricting back pain (hazard ratio [HR] 1.30; CI 1.07 – 1.32) and persistent or recurrent back pain (HR 1.48; CI 1.13 – 1.94) (Makris *et al.*, 2014). A systemic review of 165 articles on prevalence of LBP showed that the problem is more prevalent among female gender (Hoy *et al.*, 2012).

2.5.1 (c)   Body Mass Index

Obesity, defined as excessive accumulation of fat that may affect health, is classify, among all, based on body mass index (BMI). According to the World Health Organization (WHO) definition, a BMI of 25 or greater is considered overweight, whereas a BMI of 30 and more is considered as

obese (WHO, 2014). The risk of LBP increases with increasing body mass index (BMI). Obesity and physical inactivity were the independent risk factors for LBP (Shiri *et al.*, 2013). In a large epidemiological study involving more than 800,000 adolescents, LBP was found to be significantly associated with overweight and obesity, both in male (for overweight, OR 1.097, *p* value < 0.001; for obesity, OR 1.163, *p* value < 0.001) and female subjects (for overweight, OR 1.174, *p* value < 0.001; for obesity OR1.211, *p* value < 0.001) (Hershkovich *et al.*, 2013). Recently, a cross-sectional study involving 6,796 US populations showed that 7.7% - 11.6% of obese people (BMI of 31 kg/m^2 and more) were at risk of experiencing LBP, as opposed to only 2.9% among people with normal BMI (20 – 25 kg/m^2) (Smuck *et al.*, 2014). Another recent study involving 145 middle-aged women subjects also demonstrated that, independent of their recreational activities, obese participants who involved in predominantly physical activities at work have high level of LBP compared to the non-obese participants (Urquhart *et al.*, 2014).

A systemic review of studies based on twin subjects also showed that obesity was associated with LBP (pooled OR, pOR 1.9, CI 1.6 – 2.2) (Ferreira *et al.*, 2013a). Meanwhile, a study on nearly 13,000 adults in Taiwan showed that the obesity was associated with LBP, both in poor people (Hazard Ratio, HR 1.74) and in higher socioeconomic group (HR 1.24) (Hu *et al.*, 2013).

2.5.1 (d)   Marital status

A number of studies look into a relation between marital status and LBP. Apparently being married or staying with a partner was found to have