AENSI Journals

Advances in Environmental Biology

ISSN-1995-0756 EISSN-1998-1066

Journal home page: http://www.aensiweb.com/AEB/

Towards Closing the Discrepancy of Pilot Anthropometry and Aircraft Seat Dimension for Reducing Lower Back Pain (Lbp) Among Fighter Pilots

[1]Nik Aizan, N.A., [2]Ibrahim, R., [3]Mohd Rafee B., [4]Raja Ahmad Azmeer R.A.A. and [5]Mohd Zaki, M.Z.

[1]Ph.D Candidate, Faculty of Design and Architecture Universiti Putra Malaysia,
[2] Professor, Faculty of Design and Architecture Universiti Putra Malaysia,
[3] Senior Lecturer, Faculty of Medicine and Health Science Universiti Putra Malaysia,
[4] Senior Lecturer, Faculty of Design and Architecture Universiti Putra Malaysia
[5] Director, Engineering Department of Royal Malaysian Air Force

ARTICLE INFO

Article history:
Received 28 September 2015
Accepted 15 November 2015
Available online 24 November 2015

Keywords:
Lower Back Pain, Occupational Hazard, Aircraft Pilot

ABSTRACT

Background: Severe Lower Back Pain is An Occupational Hazard among the Aircraft Pilot. **Objectives:** The aim of this paper is to propose an experimental procedure involved to determine the anthropometry difference between local aircraft pilots and western aircraft pilots. The study proposes understanding the relationship between the occurrences of LBP and the dimension of the aircraft seat. **Results:** LBP will be measured objectively by using Electromyogram (EMG) and expecting to provide information on the causes of LBP. The experiment will be used to come out with a solution to reduce the discrepancy of aircraft seat dimension and pilot anthropometry. **Conclusion:** This study outcome will be proposed to improve the survival among the aircraft pilot by enhancing the operational environment in the cockpit. In addition, the data gathered from the study is also can be used to design the products for aircraft purposes. Indirectly, performance among aircraft pilots whom serve for the nation will be increased. In conclusion, this study posits on the reduction of gap between aircraft seat and pilot dimension via physical ergonomics intervention and integration of dynamic components which taking consideration of biomechanical requirement.

To Cite This Article: Nik Aizan, N.A., Ibrahim, R., Mohd Rafee B., Raja Ahmad Azmeer R.A.A. and Mohd Zaki M.Z., Towards Closing The Discrepancy Of Pilot Anthropometry and Aircraft Seat Dimension For Reducing Lower Back Pain (Lbp) Among Fighter Pilots. ***Adv. Environ. Biol., 9(23),*** *224-228, 2015*

INTRODUCTION

Lower Back Pain has been identified as one of the most costly occupational hazard among the world wide working population. In Malaysia, lower back injury is the commonest type of work related musculoskeletal which is about 50%. [12] In fact, work related low back pain is a major cause of work absenteeism and account for a high proportion of occupational disability costs whereby its account for 70% of all compensation costs. [12] One of the commonly cited risk factors of occupational related LBP is sitting beside heavy physical work, heavy lifting and non-neutral postures such as forward bending and trunk rotation [2]. Both industrial and non-industrial occupational groups could be affected from work related LBP.

Pilots are just as susceptible to lower back pain then the general population due of the nature of their work. Pilots must be confined to a cockpit for hours on end without having the chance to get up and stretch their muscles. Military pilots, especially fighter pilots, engage in high speed aerobatic maneuvers that can put a tremendous amount of stress on the body. A few studies conducted to support those statements for examples in 1996, Sheard *et al*, performed a case control study between staff Naval flying military personnel (161) compared to a control group of randomly selected non-flying military personnel (310) to quantify the incidence of low back pain. Result shows that flying military personnel (82%) experience significantly more back pain than controls (52%) ($p < 0.01$) though the nature of pain was similar in both groups [25]. According to study reported by Yoshihara *et al* in 1999, lower back pain has been considered one of the significant problems in pilot mainly fighter and jet trainer pilot resulted from G-load, pilot positioning during operation.

Lower back pain in pilot described as uncomfortable body posture during prolonged flights resulting from the lack of lumbar support exerted highest effect on pain provocation [29]. According to Dara S *et al*,

Corresponding Author: Nik Aizan, N.A., Ph.D Candidate, Faculty of Design and Architecture Universiti Putra Malaysia, Tel: 60389464090; E-mail: rahinah@upm.edu.my

ergonomics design of instruments and equipment in the cockpit plays an important role in how the pilot perform during flight. A pilot is considered stationary worker therefore, the cockpit seat needs to be designed with particular attention.

Derived from literatures review above, the main source of LBP fighter pilot is poorly ergonomic seat that resulted in improper sitting posture in the cockpit. Researcher therefore decided to perform a study to identify the occurrence of lower back pain among local aircraft pilot in related to aircraft seat.

Methodology:

The aim of this study is to determine the anthropometry difference between local aircraft pilots and western aircraft pilots. Beside that, the association between dimensions of existing aircraft seat and the pilot anthropometric will be identified. An experimental procedure will be performed in order to study the relationship between the occurrences of LBP and the dimension of the aircraft seat. In this experiment, LBP will be measured objectively by using Electromyogram (EMG). The result expected to provide information on the causes of LBP. Data gathered from the experiment will be used to come out with a solution to reduce the discrepancy fighter seat dimension and local fighter pilot anthropometry

Pilot anthropometry:

Pilot's anthropometry measurements play an important role in design of aircraft seat. The dimension of aircraft seat should be based on pilot's anthropometry. Thus, the incompatibility between pilot and aircraft seat would not occur. Failed to comply to this principle will lead to occurrence of work related lower back pain. Anthropometric data varies considerably between regional populations [24]. Therefore, anthropometrics data of the local fighter pilot expected to be different from western. In this study, the anthropometry data of local pilot will be gathered. The height, sitting height, leg length, thigh length and weight are among the variables will be measured. We aimed to identify the most critical variable, which could lead to LBP among the local aircraft pilot.

Awkward posture and LBP:

Incompatibility between users and workstation or tools will result in awkward posture. Awkward posture or inappropriate posture is used to describe the human position in which the head and shoulders are placed forward of the spine with the spine curved into an excessive S-shape, or a C-shape and it is widely referred to as a slouched or hunchback posture. According to the Theory of posture in normal body position, the human head is perfectly balanced on top of the spine that has a slight S-shape to absorb the pressures of movement as the persons sits, stands or walks. Any factor that alters or exaggerates of the natural shape will throw the weight of the head away from the center of the gravity and put mechanical strain on the spinal muscles and cause muscle tension and pain as occurred in awkward position. Hence, awkward posture is commonly associated with lower back pain, which presented as tiredness and ready fatigability.

Workstation and LBP:

Poorly designed workstation can cause LBP among the users resulting from awkward posture. Thus, Appropriate posture and properly design workstation is important to help in reducing or preventing LBP. It has been cited in a few studies [12,26] that work related MSD such as LBP could be prevented by appropriate ergonomic job design of the workstation, equipment or product. Reports on ergonomic research and intervention in the Asia Pacific region cover wide range of working condition issues such as anthropometry, workload, work posture, working hours, workstation designs and work organization. As regard to sitting posture, seat is the most vital element of workstation. Therefore, a properly designed workstation according to anthropometry of the user along with appropriate posture is important to help in reducing or preventing back stress and fatigue caused by discomfort of an inappropriate posture.

Anthropometric data:

Anthropometry is the measurement of physical characteristic and abilities of people. According to Zhang *et al*, Anthropometric consideration is a strong influence parameter on comfort in sitting [33]. The most important thing, anthropometric data provides essential information for the appropriate design of occupational and non-occupational environments as well as for the design of consumer products, clothing, tools and equipment [30].

In conclusion, the workstation for a pilot is cockpit. Incompatibility of its element particularly aircraft seat will lead to awkward posture resulted in LBP among aircraft pilot. Aircraft cockpit and its elements are designed based on the anthropometric characteristics of European pilots. Many studies on body dimension or anthropometry revealed that body sized differed greatly between European and Asian population. Hence, In order to design appropriate aircraft seat to fit for the local people, anthropometry studies are increasingly important. The researcher posits, by incorporating of pilot anthropometry information of Asian pilots into aircraft seat design will help to provide good posture and to reduce occupational related LBP among them.

Advances in Environmental Biology, 9(23) October 2015, Pages: 224-228

Aircraft Seat Dimension:

The aircraft seat dimension ideally should be based on pilot's anthropometry to facilitate the accommodation of the pilot within the cockpit and to avoid work related LBP resulted from awkward sitting posture. Most of the Malaysian aircraft seats were designed base on European anthropometry characteristic. The different of body dimension between European and Asian reflect the presence of mismatch between aircraft seat and Malaysian pilot. The mismatch will lead to improper sitting position, later lead to LBP. The best remedial measure to overcome above problem is to redesign the aircraft seat to suit our pilot. However, this solution will involve huge amount budget and complex engineering system. Hence, Its motivate the researcher to carry out this study with the aim of to figure out a solution in reducing LBP among local aircraft pilot.

Seat design consideration:

Beside anthropometry, biomechanical consideration is another important parameter needs to take into account in designing aircraft seat [31,33]. Biomechanical dimension such as seat backrest angle and seat inclination, lumbar support, seat height, seat depth, thigh support length and backrest height need to be considered. Failed to provide biomechanical need such as lumbar support resulted in LBP among aircraft pilot [15]. In addition, it is necessary to concentrate on the human aspect of the cockpit design. Therefore, understanding the flying behavior of the pilots or activities of the pilot within the cockpit will give ideas in designing a solution for reducing LBP.

Seat compatibility:

Aircraft seat design should compatible with pilot's body dimension in order to provide ergonomics work environment [18].

From above statements, we can deduce that aircraft seat design needs to full filled biomechanical requirement of the pilot. In reducing the gap between aircraft seat dimension and pilot anthropometry will improve compatibility among them and in directly will reduce the risk of LBP

Reducing Lower Back Pain (Lbp):

Lower back pain (LBP) is an occupational hazard (Aaras, 2001; Punnet *et al*, 2005). Back pain is a well-known occupational hazard in many types of occupations. Lower back pain (LBP) is also known occupational hazard among the worldwide aircraft crew. Occupational hazard is a serious issue because aircrews spend the largest proportion of their time in the cockpit.

Causes (Etiology):

Sitting has been recognized as one of the risk factor for the LBP. Sitting in awkward posture on non-ergonomics seat will lead to LBP [14]. Awkward posture or inappropriate posture is used to describe the human position in which the head and shoulders are placed forward of the spine with the spine curved into an excessive S-shape, or a C-shape and it is widely referred to as a slouched, or hunchback posture. According to the Theory of posture in normal body position, the human head is perfectly balanced on top of the spine that has a slight S-shape to absorb the pressures of movement as the persons sits, stands or walks. Any factor that alters or exaggerates of the natural shape will throw the weight of the head away from the center of the gravity and put mechanical strain on the spinal muscles and cause muscle tension and pain as occurred in awkward position. Hence, awkward posture is commonly associated with backaches of tiredness and ready fatigability.

A systemic literature review which was restricted to pilot occupation, musculoskeletal disorder as occupational hazards and work performance showed the aircraft seat, which does not fit to the pilot such as physical, would lead to discomfort and severe musculoskeletal disorder and this will affect performance of the pilot. Other factors are duration of sitting, vibration, movement while operating the aircraft and G-force.

Preventive measures:

According to Hawkins [13] complaints of discomfort in the cockpit are related to stress, and to the inappropriate cushioning of pilot seats. To mitigate occupation related LBP, physical ergonomics of the workstation need to improve [9]. Lyons J, 2002 further support that ergonomics can play an important role in the reduction of risk of injury to the professional driver by implementing modifications to the work place (engineering controls).

Based on literatures, we believed, application of Physical ergonomics intervention would improve workstation design. Thus, reduce of occupational related LBP in prolong sitting and awkward posture.

RESULTS AND DISCUSSION

The expected result of the study would include anthropometric data difference between local and western aircraft pilot. In addition, this study data expected to reveal information regarding the association between

aircraft seat dimension and pilot anthropometry that explained the occurrence occupational hazards among. A part from that, the electromyogram test will demonstrate presence of muscle strain, which resulted from awkward posture.

From the main expected results above, researcher anticipated that this research would be a significant impact in which could reduce the LBP. Researcher will come out with a solution in order to reduce the gap between existing local aircraft seat and pilot anthropometry. Thus, reduce the risk of LBP among the aircraft pilot.

Besides, the researcher foresees, anthropometric data gathered from this study can be used for the future design of the equipment related to pilot's need and satisfaction. This Asian Percentile Data (APD) can be used for designing other products for aviation purposes. This study will contribute in improving survival by enhancing the operational environment in the cockpit.

Conclusion:

For the conclusion, literature reviewed has shown that the main source of LBP fighter pilot is poorly ergonomic seat that resulted in improper sitting posture in the co Incompatibility of its element particularly aircraft seat will lead to awkward posture resulted in LBP among aircraft pilot cockpit. Aircraft cockpit and its elements are designed based on the anthropometric characteristics of European pilots whom known to have bigger body sized than Asian population. In addition to anthropometry, an aircraft seat design needs to full filled biomechanical requirement of the pilot From this study, the researcher finding will provide anthropometric data and will revealed the mismatch of aircraft seat to the local aircraft pilot. Reduction gap between aircraft seat and pilot dimension could be achieved by integrating the anthropometric and biometric parameters together with application of physical ergonomic in designing the remedial measure.

ACKNOWLEDGEMENT

The author thanks Dr Rozita Ismail for her dedicated work in assisting the author to understand medical terms that related to lower back pain used in this article as a part of the study.

REFERENCES

[1] Aaras, A., 2001. Musculoskeletal, visual and psychosocial stress in VDU operators before and after multidisciplinary ergonomics interventions: a 6 years prospective study - part II. Appl Erg, 32: 559-571.
[2] Angela, M.L., 2007. Association between sitting and occupational LBP. Eur Spine J; 16:283–298 DOI 10.1007/s00586-006-0143-7
[3] Burdorf, A., 1990. An epidemiological study of low-back in crane operators. Ergonomics, 33(8): 981–987.
[4] Bovenzi, M., 1999. An update review of epidemiologic studies on the relationship between exposure to whole body vibration and low back pain (1986–1997). Int Arch Occup Environ Health, 72: 351–365.
[5] Bovenzi, M., 1994. Low-back disorders in agricultural tractor drivers exposed to whole body vibration and postural stress. Appl Ergon, 25(4): 231–241.
[6] Chandrasakaran, A., 2003. The Prevalence of Musculoskeletal Problems and Risk Factors Among Women Assembly Workers in the Semiconductor Industry. Med J Malaysia, 58(5).
[7] Cunningham, L.K., 2010. Prevalence of Low Back Pain (LBP) in Rotary Wing Aviation Pilots. Aviat Space Environ Med., 81(8): 774-8
[8] Coury, B.G. and C.G. Drury, 1982. Ergonomics, Optimal handle positions on boxes: A multifactorial approach.
[9] Durkin, J.J., 2006. The effects of lumbar massage on muscle fatigue, muscle oxygenation, low back discomfort, and driver performance during prolonged driving. Ergonomics, 49(1): 28-44.
[10] Goossens, R.H.M., 1999. Biomechanical Analysis of The Dimension of Pilot Seats in Civil Aircraft. Applied Ergonomics, 31: 9-14.
[11] Hasan, A.A.A., 2007. Anthropometric Profile of Elite Male Handball Players in Asia. Biology of Sport, 24: 3-12.
[12] Hashim, Y., 2012. Work Related Musculoskeletal Disorders (WRMSDs): An Overview among Malaysian Industrial Employee. UMT 11th International Annual Symposium on Sustainability Science and Management
[13] Hawkins, F.H., 1973. Crew seats in transport aircraft. Shell Aviation News, 418: 14-21.
[14] Hoogendorn, W.E., 2000. Flexion and rotation of the trunk and lifting at work are risk factors for low back pain. Spine, 25: 3087-92.
[15] Ivelic, Z., 2002. Office Furniture Design According To A Human Anthropometric Data. International Design Conference-Design, Dubrovnik
[16] Jeffrey, A., 2013. Rotary Pilot Low Back Pain in Relation to Occupational Hazard-A Case Report. Medical Corps International Forum

[17] Jorgensen, K., 1997. Human trunk extensor muscles physiology and ergonomics. Acta Physiol Scand Suppl, 637: 1-58.
[18] Kenneth, W., 1986. International Anthropometric Variability and Its Effects on Aircraft Cockpit Design. Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, Ohio, U.S.A.
[19] Kroemer, 1989. Cumulative trauma disorders: their recognition and ergonomics measures to avoid them. Applied Ergonomics, 20(4): 274–280.
[20] Lyons, J., 2002. Factors contributing to low back pain among professional drivers: a review of current literature and possible ergonomic controls. Work,19(1): 95-102.
[21] Nicole, L., 1999. Cause, Prevalence, and Response to Occupational Musculoskeletal Injuries Reported by Physical Therapists and Physical Therapist Assistants PHYS THER, 79: 642-652.
[22] Punnett, L., 1991. Back disorders and non-neutral trunk postures of automobile assembly workers. Scand J Work Environ Health, 17: 337-46
[23] Srinivasan, J., 2007. Low back pain and muscle fatigue due to road cycling-An sEMG study. Journal of Bodywork and Movement Therapies, Elsevier., 11(3): 260-266.
[24] Scott, T., 2006. Demonstrating the Feasibility of Using Forearm Electromyography for Muscle-Computer Interface. CHI Proceeding, Physiological Sensing for Input.
[25] Sheard, S.C., 1996. Back pain in aircrew--an initial survey. Aviat Space Environ Med., 67(5): 474-7.
[26] Snook, S.H., 1978. A study of three preventive appropriate to low back injury. J. Occup. Med., 20: 478-481.
[27] Stanley, R., 2000. Poorly ergonomic seat that resulted in improper sitting posture in the cockpit, 47-53.
[28] Thomae, M.K., 1998. Back Pain in Australian Military Helicopter Pilot: A Preliminary Study. Aviation, Space and Environmental Medicine, 69: 468-473.
[29] Truszczynska, A., 2012 Back Pain in Military Helicopter Pilots. Int Occup Med Environ Health, 25(3): 258-64.
[30] Victor, P., 2003. An anthropometric study of manual and powered wheelchair users. International Journal of Industrial Ergonomics, 33: 191–204.
[31] Wachsler, R., 1960. An analysis of some factors influencing seat comfort. Ergonomics, 33: 315-320.
[32] Yoshihara, Y., 1999. Low Back Pain and Neck Pain of JASDF Fighter Pilots: Subjective Evaluation of Surroundings in Flying Aircraft. National Defence Medical Journal, 46(3): 79-85.
[33] Zhang, L., M.G. Helander, C.G. Drury, 1996. Identifying factors of comfort and discomfort in sitting. Human Factors, 38: 377-389.