



UNIVERSITI PUTRA MALAYSIA

**ASSOCIATION BETWEEN ERGONOMIC RISK FACTORS AND
MUSCULOSKELETAL SYMPTOM AMONG AUTOMOBILE
ASSEMBLY LINE WORKERS IN SHAH ALAM, SELANGOR**

AMIN YAZDANI

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LINE WORKERS IN SHAH ALAM, SELANGOR**

BY

AMIN YAZDANI

**Thesis submitted to the School of Graduate Studies, University Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

July 2009



DEDICATION

TO

**Dedicated especially to my parents, my brother (Davood) and all those individuals
behind the sense who make me possible to complete my study successfully**



Abstract of thesis presented to the Senate of University Putra Malaysia in fulfillment of
the requirement for the degree of Master of Science

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By

Amin Yazdani

July 2009

Chairman: Dr. Anita Binti Abd Rahman

Faculty: Medicine and Health Sciences

A cross-sectional study was conducted to determine the prevalence of MSD symptom and also ascertain the association between MSD symptom and its risk factors among automobile assembly line workers. A simple random sampling method was adopted and data were collected via face-to-face interview and posture assessment method based on Standardized Nordic Questionnaire (SNQ) and Rapid Upper Limb Assessment (RULA) method from April to August 2008. A total of 232 assembly line workers with at least one year job tenure participated in this study. The finding revealed that 78.4% of workers reported MSD symptoms while low back had the highest prevalence of MSD symptoms (50.9%). Three factors were found to be significantly associated with MSD symptom;



age ($\chi^2=5.609$, $p = 0.018$), job tenure ($\chi^2 = 8.260$, $p = 0.008$) and awkward posture ($\chi^2 = 65.372$, $p =0.001$). Logistic regression test indicated that young workers (< 25 years old) were less likely to complain MSD symptoms (OR= 0.314, 95%CI= 0.129-0.770) compared to older workers. Moreover, workers with equal and more than 3 years job tenure were 2 times more likely to complain of MSD symptoms (OR= 2.422, 95%CI= 1.042-5.629) when compared to those with less than 3 years job tenure. In addition, workers in the very high RULA action level were 69 times (OR= 69.383, 95%CI= 14.511-331.734) and workers in the high RULA action level (OR=12.415, 95%CI= 5.210-29.458) were 12 times, more likely to complain MSD symptom as compared to those workers in the low and intermediate RULA action level. The high prevalence of MSD shows that MSD symptom is a significant problem among automobile assembly line workers. Consistent with other studies, the result of this study indicated that age, job tenure and awkward posture are the significant risk factors for MSD symptom. In particular, this study proves that the prevalence of MSD symptom increases as the RULA action level and job tenure increases. Thus, given the association between awkward posture and prevalence of MSD symptom, this problem could be reduce by decreasing RULA action level through appropriate ergonomic workstation design and ergonomic training for workers.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai keperluan untuk memenuhi ijazah Sarjana Sains

**PERHUBUNGAN ANTARA FAKTOR ERGONOMIK DAN SIMTOM
MASALAH MUSKULOSKELETAL DI KALANGAN PEKERJA-PEKERJA
PEMASANGAN AUTOMOBIL DI SHAH ALAM, SELANGOR**

Oleh

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Satu kajian irisan lintangan telah dijalankan untuk mengenalpasti prevalen simptom masalah muskuloskeletal serta faktor-faktor risikonya di kalangan kumpulan pekerja-pekerja automobil. Persampelan rawak mudah digunakan dan maklumat yang dikumpulkan adalah melalui temuramah dan kaedah taksiran postur dengan menggunakan borang soal selidik *Standardized Nordic Questionnaire (SNQ)* dan kaedah taksiran *Rapid Upper Limb Assessment (RULA)* dari bulan April hingga Ogos 2008. Seramai 232 orang pekerja automobil dengan sekurang-kurangnya satu tahun pengalaman kerja telah menyertai kajian ini. Keputusan menunjukkan 78.4% pekerja melaporkan simptom masalah muskuloskeletal dengan bahagian bawah belakang mempunyai prevalen yang paling tinggi bagi simptom masalah muskuloskeletal (50.9%).



Tiga faktor mempunyai kaitan yang signifikan dengan simtom masalah muskuloskeletal iaitu umur ($\chi^2=5.609$, $p = 0.018$), tempoh bekerja ($\chi^2 = 8.260$, $p = 0.008$) dengan postur canggung ($\chi^2 = 65.372$, $p =0.001$). Ujian regresi logistik menunjukkan bahawa pekerja-pekerja yang berumur bawah daripada 25 tahun kurang mengadu simtom masalah muskuloskeletal (OR= 0.314, 95%CI= 0.129-0.770) berbanding dengan pekerja yang berumur lebih atau sama dengan 25 tahun. Selain itu, pekerja dengan tempoh bekerja lebih atau sama dengan 3 tahun adalah 2 kali lebih berisiko untuk mengadu simtom musculoskeletal (OR= 2.422, 95%CI= 1.042-5.629) berbanding dengan mereka yang bekerja kurang daripada 3 tahun. Tambahan pula, pekerja yang berada pada peringkat aksi RULA yang sangat tinggi adalah 69 kali (OR= 69.383, 95%CI= 14.511-331.734) dan pekerja-pekerja dalam peringkat aksi RULA yang tinggi (OR= 12.415, 95%CI= 29.458) adalah 12 kali lebih berisiko untuk mengadu simtom masalah muskuloskeletal berbanding dengan pekerja-pekerja di peringkat aksi RULA bawah dan tengah. Prevalen masalah muskuloskeletal yang tinggi ini menunjukkan bahawa muskuloskeletal simtom merupakan masalah yang signifikan di kalangan pekerja-pekerja di industri automobil. Konsisten dengan kajian yang lain, keputusan kajian ini menunjukkan, bawah umur, tempuh bekerja dan postur canggung adalah faktor yang signifikan untuk muskuloskeletal simtom. Selain itu, kajian juga telah menunjukkan peninykatan tren di antara pembolehubah yang dikaji dimana prevalen masalah muskuloskeletal meningkat dengan peningkatan peringkat aksi RULA. Bagi perkaitan di antara postur canggung dan prevalen simtom muskuloskeletal boleh diminimakan dengan pengurangan peringkat aksi RULA melalui susun atur tempat kerja yang ergonomik dan memberikan latihan ergonomik kepada pekerja-pekerja.

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I certify that an Examination Committee has met on date of viva voce to conduct the final examination of Amin Yazdani on his Master of Science “Association between awkward posture and musculoskeletal symptom among automobile assembly line workers” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The committee recommends that student be awarded the Master of Science. Members of Examination Committee were as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotation and citation which have been duly acknowledged. I also declare that it has not been previously or concurrently for any other degree at UPM or other institutions.

AMIN YAZDANI



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LIST OF ABBREVIATIONS

BMI	Body Mass Index
CO	Carbon Monoxide
EMG	Electromyography
ENMG	Electroneuromyography
MSD	Musculoskeletal Disorder
MRI	Magnetic Resonance Imaging
NCV	Nerve Conduction Velocity
HSE	Health and Safety Executive
OSHA	Occupational Safety and Health Administration
OICA	Organisation Internationale des Constructeurs d'Automobiles (International Organization of Motor Vehicle Manufacturers)
RULA	Rapid Upper Limb Assessment
QEC	Quick Exposure Check
SNQ	Standardized Nordic Questionnaire
SOCISO	Social Security Organization
SPSS	Statistical Package of Social Science
UK	United Kingdom
USA	United States of America
UPM	University Putra Malaysia
WHO	World Health Organization



CHAPTER 1

INTRODUCTION

1.1 Automobile Industry

According to the International Organization of Motor Vehicle Manufacturers (OICA) in 2007, more than 73 million motors vehicles, including cars and commercial vehicles were produced worldwide and a total of 71.9 million new automobiles were sold worldwide: in Europe 22.9 million, Asia-Pacific 21.4 million, United States of America (USA) and Canada 19.4 million, Latin America 4.4 million, Middle East 2.4 million and in Africa 1.4 million respectively. A large number of workers, almost 1,605,000 workers in China, 955,000 workers in USA, 270,000 workers in India and 64,000 in Indonesia were employed in this industry.

Automobile industry in Malaysia is a booming industry which encompasses the design, development, manufacture, marketing, and sale of motor vehicles. It is one of the principal producers and exporters of vehicle parts, components and accessories, which are widely accepted by most of the leading countries such as Japan, United Kingdom



(UK), Thailand, Taiwan, Singapore, and Indonesia. In Malaysia, as reported in Global Market Data Book (2008), the number of cars being produced annually has also increased. For instance, in 1999, 254,000 cars were manufactured while in 2007, the production doubled to 442,000 cars. In order to meet this demand, a large numbers of workers is being employed in this industry and according to OICA (2007) as many as 47,000 workers were employed. Being an industry with significant number of working population, the health and safety issues of the workers should not be neglected.

1.1.1 Automobile manufacturing process

The manufacturing of an automobile involves compound tasks with several steps of machining and assembling. Typically, large components of a car such as body and engine are assembled over multiplied system. The three main stages involved in an automobile manufacturing are: the body shop, the paint shop and the assembly shop (Figure 1.1).



Figure 1.1 Stage of the automobile manufacturing process

The body shop consists of a process where the vehicle body is created by welding together steel sections to form the structure. While, the paint shop is dealing with process where the vehicle body is cleaned, coated with rust protection, and painted with

a prime-coat, colored base-coat, and a protective top-coat. The assembly shop involved the processes where the vehicle components, such as the engine, windshield, tires, instrument panel, and seats, are installed as the body passes along the assembly line.

An automobile company will typically sequence cars based on several objectives, most dealing with line balancing and material management. In the first and last stages (the body shop and assembly shop), different cars require the installation of different components. Some of the differences are due to:

- i. Different option of the same car model (e.g. one car might have an automatic transmission and sunroof, while another car might have a manual transmission, but no sunroof).
- ii. Different type of the same model (e.g. Sedan and Wagon).
- iii. Different model assemble in the same line.

1.1.2 Automobile assembly line

The assembly of the machine or device is the process of fitting its part together. The assembly line process is extremely complex and involves the installation of several hundred parts of machine component. Each automobile manufacturer has its own design and the assembling processes are modified by their level of technology. Assembly shop consists of three lines which includes three main processes:

- i. Trim: in this process, several sub processes are performed such as: installing the floor carpets, doors wire, glasses wire and doors supply.

- ii. Chassis: in this main process the assembling of the main parts of car are performed. Some of the sub processes are includes engine, tyer, bumper and exhaust installing.
- iii. Final: is the last process in an assembly line. In this process, the assembling process is completed the main sub processes of this process include: door, seat and windshield installing.

The cars produced are examined by quality control experts in several parts of the line. In order to assemble extra facilities, ordered cars, are leaded to accessory line where some changes (depend on the client order) are performed.

1.2 Health and safety hazards in an automobile assembly line

The interaction between complex tools, machines, and instruments, coupled with many workers pose several health hazards. Thus, health and safety in an assembly shop of automobile industries has become extremely important. Since the 1970s, a great deal of research has been done on various environmental factors related to safety in the workplaces. Within automobile assembly line, the environmental hazards can be classified as chemical, physical, psychosocial and ergonomic hazards. These factors can cause sickness, impaired health, and significant discomfort to workers and even death in some cases.



1.2.1 Chemical hazard

Chemical hazard arise from high concentrations of vapors or gases such as Carbon Monoxide (CO) which is produced by switching on the car after final line for the first time. The first gas that will be exhausted from a car is a complex of CO which is a poisonous gas produced by incomplete burning of carbon-based fuels, including gas and oil which is colorless, odorless and tasteless. It can increase cardiovascular (heart and blood system) problems among workers. CO can cause carboxyhemoglobin that can lead to hypoxic and death (Acarturk, 1994). To overcome the problem, the use of an exhaust fan in the final process can eliminate this hazard. Other chemicals that are being using in an automobile assembly line includes variety type of oils, greases and fuels which have different health and safety effects.

1.2.2 Physical hazard

Physical hazards can arise from excessive level of noise, vibration, temperature and pressure at workplace. Exposure to high level of noise in some part of an assembly line such as chassis process can cause hearing impairment, hypertension, heart disease, annoyance, sleep disturbance, and decreased performance. Beyond these effects, elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression and other anti-social behaviors. Vibration-induced White Finger (VWF) is a common condition among the operators of hand-held vibrating tools which are being used in automobile assembly line. Vibration can cause changes in tendons, muscles, bones and joints, and can affect the nervous system (CCOHS, 2007). To reduce the

vibration of tools, some engineering method such as using vibration killer was applied in the assembly line.

1.2.3 Psychosocial hazard

Psychosocial hazards such as monotonous work, lack of encouraging organizational culture, and anxiety concerning change and job dissatisfaction which can pose workers to be at risk are some of the psychosocial hazards belong with other occupational health and safety factors pose automobile assembly line workers to develop occupational diseases. Minimizing these risk factors can prevent occupational injuries in this industry.

1.2.4 Ergonomics hazard

Ergonomics is the study of human characteristics for the appropriate design of the living and working environment. Ergonomics hazards are defined as a condition that is related to the position or proper function of one's body or to motion. Ergonomics hazard in assembly line include poorly design tools, work speed, improper lifting or reaching and awkward working posture. The main health problem caused by ergonomic hazards are Musculoskeletal Disorders (MSD) which is one of the most important problems encountered by ergonomist in the workplace around the world (Vanwonderghem., 1996). In the automobile assembly line awkward working posture could be a main ergonomic hazard for MSD which this thesis focused on.