THE ASSOCIATION OF SHIFT WORK AND CORONARY HEART DISEASE RISK FACTORS AMONG MALE FACTORY WORKERS IN KOTA BHARU, KELANTAN

by

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This manuscript is dedicated to:

My wife

Puan Shaharuni Binti Mat Nawi

My daughter

Nurul Qistina Binti Mohd Nazri

My parent

En. Shafei Bin Abd. Rahman

Puan Zaidah Binti Daud

My parent in-law

Tn. Hj. Mat Nawi Bin Muhammad

Pn. Hjh. Raizam Binti Muhamad

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LIST OF ABBREVIATIONS

BMI	- Body Mass Index
BP	- Blood Pressure
CAD	- Coronary Artery Disease
CHD	- Coronary Heart Disease
CVD	- Cardiovascular Disease
DALYs	- Disability-adjusted Life Years
FBS	- Fasting Blood Sugar
FLP	- Fasting Lipid Profile
HDL	- High Density Lipoprotein
IC	- Integrated Circuits
IHD	- Ischemic Heart Disease
IR	- Insulin Resistance
LCD	- Liquid Crystal Displays
LDL	- Low Density Lipoprotein
LED	- Light Emitting Diodes
MOH	- Ministry of Health
NCEP	- National Cholesterol Education Program
OR	- Odds Ratio
REM	- Rapid Eye Movement
SMS	- Shift work Maladaption Syndrome
TC	- Total Cholesterol
USM	- Universiti Sains Malaysia
VIF	- Variance-Inflation Factor
WHO	- World Health Organization

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ABSTRAK

TAJUK: HUBUNGAN ANTARA KERJA SYIF DAN FAKTOR-FAKTOR RISIKO BAGI PENYAKIT JANTUNG KORONARI DALAM KALANGAN PEKERJA KILANG LELAKI DI KOTA BHARU

PENGENALAN: Kemodenan telah banyak merubah pelbagai aspek kehidupan dengan cepat termasuklah aspek ekonomi, sosial dan tingkah-laku manusia. Ini telah menyumbang kepada penggunaan berbagai-bagai jadual kerja oleh organisasi-organisasi. Masa bekerja telah dilanjutkan kepada petang, malam dan juga pada hujung minggu. Kerja syif merupakan satu cara bekerja di mana pekerja-pekerja akan bertukar ganti melebihi waktu bekerja biasa. Ia berpotensi untuk mengganggu ritma biologikal yang normal atau keperluan sosial atau kedua-duanya sekali. Ramai penyelidik mendapati bahawa pekerja syif lebih berisiko untuk mendapat pelbagai penyakit dan juga mendapat faktor risiko bagi panyakit jantung koronari (CHD) seperti hipertensi, hiperkolesterolemia, obesiti dan diabetes mellitus (DM).

OBJEKTIF KAJIAN: Kajian ini dijalankan untuk menentukan hubungkait antara kerja syif dan faktor-faktor risiko CHD. Faktor-faktor risiko tersebut adalah tekanan darah tinggi, dislipidemia (samada hiperkolesterolemia, hiper-lipoprotin berketumpatan rendah-kolesterolemia, hipo-lipoprotin berketumpatan tinggi-kolesterolemia atau hipertrigliseridemia), indeks jisim badan (BMI) tinggi, diabetes mellitus dan gaya hidup tidak aktif dalam kalangan pekerja kilang lelaki di Kota Bharu, Kelantan.

METODOLOGI: Kajian irisan-lintang ini melibatkan 76 orang pekerja shif dan 72 orang pekerja harian daripada sebuah kilang yang terletak di Kota Bharu, Kelantan. Data diperolehi menggunakan borang soal-selidik berkenaan psikososial dan gaya

hidup. Ukuran antropometri dan tekanan darah, analisa glukosa darah dan profail lipid ketika berpuasa dijalankan. Ujian 'Chi-square' dilakukan untuk menentukan perbezaan disegi prevalens setiap faktor risiko CHD di antara dua kumpulan pekerja berkenaan. Regresi logistik multipel (MLR) pula digunakan untuk menentukan nilai nisbah odds (OR) bagi setiap faktor risiko penyakit jantung yang dikaitkan dengan kerja syif.

KEPUTUSAN: Prevalens bagi tekanan darah tinggi, hiperkolesterolemia, hipertrigliseridemia dan BMI yang sama dengan atau melebihi 25 kg/m^2 adalah lebih tinggi dalam kalangan pekerja syif berbanding pekerja harian. Prevalens bagi diabetes mellitus, hipo-lipoprotin berketumpatan tinggi-kolesterolemia, hiper-lipoprotin berketumpatan rendah-kolesterolemia serta tahap aktiviti fizikal yang rendah tidak berbeza secara signifikan bagi kedua-dua kumpulan kerja berkenaan. Bila dibandingkan pekerja syif dan bukan syif, nilai 'adjusted' OR bagi tekanan darah tinggi, BMI yang tinggi dan tidak aktif masing-masing adalah 9.1 (95% CI 1.4-56.8), 2.9 (95% CI 1.3-6.1) dan 7.7 (95% CI 2.1-27.5). Sebaliknya, tidak terdapat hubungan antara kerja syif dan risiko mendapat dislipidemia ataupun diabetes mellitus (DM).

KESIMPULAN: Didapati bahawa terdapat hubungkait positif antara kerja syif dan tekanan darah tinggi, BMI yang sama dengan atau melebihi 25 kg/m^2 serta gaya hidup tidak aktif. Ini menunjukkan kemungkinan bahawa risiko untuk mendapat faktor-faktor risiko CHD adalah tinggi dalam kalangan pekerja syif berbanding pekerja harian.

Kata-kunci: kerja syif, faktor-faktor risiko, penyakit jantung koronari, prevalens, nisbah odds

ABSTRACT

TITLE: THE ASSOCIATION OF SHIFT WORK AND CORONARY HEART DISEASE RISK FACTORS AMONG MALE FACTORY WORKERS IN KOTA BHARU, KELANTAN

INTRODUCTION: Modern society is changing quite rapidly in terms of economic, social and human behaviour. Consequently, various types of work schedules have been applied by organizations and companies. Working hours are extended to evenings and nights, as well as on weekends. Shift work is one of the work hour systems in which a relay of employees extends the period of production beyond the conventional 8-hour working day. It potentially disrupts workers' normal biological or social diurnal rhythms or both. Shift work has been found to be associated with various health problems and there is a concern that shift workers are at higher risk to develop risk factors for coronary heart disease (CHD) such as hypertension, hypercholesterolaemia, obesity and diabetes mellitus (DM).

OBJECTIVES: The study was undertaken to examine relationships between shift work and CHD risk factors, namely high blood pressure (BP), dyslipidaemia (either hypercholesterolaemia, hyper-low density lipoprotein-cholesterolaemia, hypo-high density lipoprotein-cholesterolaemia or hypertriglyceridaemia), high body mass index (BMI), diabetes mellitus and physical inactivity among male factory workers in a factory in Kota Bharu, Kelantan.

METHODS: This study was a cross-sectional study of 76 shift and 72 day workers from a factory in Kota Bharu, Kelantan. Data was collected through a questionnaire on psychosocial and life-style factors. Anthropometric and blood pressure measurement,

fasting blood sugar and fasting lipid profiles analyses were obtained. Chi-square test was used to determine the significant difference in the prevalence for each CHD risk factors between the two worker groups. Multiple logistic regression was used to evaluate the odds ratio for each CHD risk factors associated with shift work.

RESULTS: The prevalence of high BP, hypercholesterolaemia, hypertriglyceridaemia and body mass index (BMI) of equal to or more than 25 kg/m^2 were significantly higher among shift workers compared to day workers. There was no difference in the prevalence of diabetes mellitus, hypo-high-density lipoprotein-cholesterolaemia, hyper-high-density lipoprotein-cholesterolaemia and physical inactivity. When the shift workers were compared with the day workers, the adjusted odds ratio (OR) for high BP, BMI of equal to or more than 25 kg/m^2 and physical inactivity were 9.1 (95% CI 1.4-56.8), 2.9 (95% CI 1.3-6.1) and 7.7 (95% CI 2.1-27.5) respectively. There was neither association of shift work with dyslipidaemia, nor with diabetes mellitus.

CONCLUSIONS: There were positive association between shift work and high BP, BMI of equal to or more than 25 kg/m^2 and physical inactivity which denotes a higher risk of CHD risk factors among shift workers compared to day workers.

Keywords: shift work, risk factors, coronary heart disease, prevalence, odds ratio

CHAPTER ONE

INTRODUCTION

1.1. Global Perspective of Shift Work

Modern society is changing rapidly both in terms of economic and productive strategies such as new technologies, market globalization and information processes. The changes also occur in terms of the social organization and individual behaviours. Time constraints no longer limit human activities. People want and are able to do everything at any hour of the day or night. Therefore, the arrangement of working hours has become a crucial factor in work organization and acquires different values according to economic and social consequences that can arise at different periods of the company and worker's life (Costa, 2003). There are various types of work schedules applied by organizations and companies in which working hours are extended to evenings and night hours, as well as to weekends. Hours of duty have become more and more variable. A previous cross-sectional study that used the public access data from the Canadian National Longitudinal Survey of Children and Youth, had broadly classified work schedules into standard and non-standard (Strazdins, *et al.*, 2004). A standard work schedule refers to those who work on weekdays and do daytime work. Whereas, non-standard work schedules refer to those who are on-call or who do any shift work and/or working during weekends.

Shift work is one of the work hour systems in which a relay of employees extends the period of production beyond the conventional 8-hour working day and that potentially disrupts workers' normal biological or social diurnal rhythms or both (Akerstedt, *et al.*,

1984, Harrington, 2001). There are thousands of shift systems used and they differ widely with respect to their structure, and in particular: the presence or absence of night work; the duration of the duty period such as from 6 to 12 hours; the number of workers or crews who cover the whole working time; the interruption of the weekend; if workers stay on a given shift, or alternate between the different shifts; the speed either fast or slow and the direction of the shifts rotation either clockwise or counter-clockwise; the start and finish times of the duty periods; and the regularity or irregularity and length of the shift cycle (Costa, 2003).

Shift work systems have been broadly classified into four which are permanently displaced workhours, rotating shift work, roster work, and unscheduled workhours (Akerstedt, *et al.*, 1984). For permanently displaced workhours, the workers are doing morning, evening or night work. Rotating shift work means that there is an alternation between thirds of the 24-hour cycle. Roster work is less regularly used by industries to assign their workers as compared to the rotating shift work. Workers who are working when they are needed refer to a class known as unscheduled work hours. This is often done by self-employed individuals.

Shift work is not a modern phenomenon. Ramazzini (1633-1714) noted that bakers, innkeepers and soldiers worked as such. Historically, bakers have worked through the night to ensure fresh bread in the morning, and in ancient Rome, deliveries were restricted to the night hours in order to relieve traffic congestion. With the initiation of the Industrial Revolution, more and more work processes required full-time operations (U.S. Congress, 1991). Today, about one in five workers in Europe (Harrington, 2001) and in the United States (U.S. Congress, 1991, Scott and LaDou, 1994) are employed on

shift work. Some sectors have a considerably higher percentage of employees on shift work. For example, capital-intensive industries and continuous-process operations may have 50% of employees working on shift and over 38% of those in service occupations are shift workers (U.S. Congress, 1991). Although the shift workers of fifty years ago were likely to be factory-based workers, increasing demand for services (both business and pleasure) has extended to those employed in traditionally known as "white collar" occupations like doctors and nurses (Harrington, 2001).

Among specific reasons for adopting shift work schedules are an extended period of time required to complete a particular job or process and a constant need or extended demand for services. Other reasons include economic factors (for example, the expense of capital investment and the need for maximum competitiveness) and technological advances (U.S. Congress, 1991).

1.2. Shift Work and Health

Shift work has been found to be associated with various health problems which do not only affect the workers but also the economic and industrial sectors. Health problems of shift workers are caused by disturbance of the biologic rhythms (Akerstedt, 2003). It is well-established that most human functions have a rhythm, the peaks and troughs of which occur in approximately a 24-hour period, known as circadian rhythms. The word "circadian" was derived from Latin "circa dies" which means "about a day". The source of the rhythms in the brain appears to be the suprachiasmatic nucleus of the hypothalamus. The nucleus receives projections from the retina (Anders, 1996). They

are determined partly by endogenous factors, the internal body clock and partly by environmental cues such as daylight, noise and the social habits of the individual (Spurgeon, 2003). Multiple physiologic, psychologic and behavioural parameters such as body temperature, serum and urinary corticosteroids and electrolytes, cardiovascular functions, gastric enzyme secretion, blood leucocyte count, muscle strength, alertness, mood and immediate and long-term memory have been observed to follow circadian rhythms (Scott and LaDou, 1994). These circadian rhythms, which are geared towards activities during the day and rest at night, are persistent and rigid and therefore do not adapt immediately to new working patterns (Taylor, *et al.*, 1997).

The change from day to late evening and night work compels the worker to modify his normal 'activity-rest' cycle, forcing him to adjust his body functions to the duty periods. This involves a progressive phase shift of circadian rhythms across the successive night shifts, but a complete inversion is never reached, except in the very rare cases of permanent night workers who maintain an inverted sleep-wake cycle on their days off. In most cases, the human body is exposed to continuous stress from attempts to adjust as quickly as possible to the varying working hours, while at the same time being invariably frustrated by the continuous shift rotations. Consequently, people suffer from a so-called 'shift lag' syndrome (Costa, 2003). The syndrome is characterized by feelings of fatigue, sleepiness, insomnia, disorientation, digestive troubles, irritability, poor mental agility and reduced performance efficiency.

There is a general agreement that the effect of shift work has a deleterious effect on sleep. The most authoritative review concludes that despite considerable variation between people, sleep loss is a major effect of shift work. These problems are mainly

due to disruption of the normal sleep-wake rhythm, of the normal circadian rapid eye movement (REM) sleep rhythm and of the rhythm of REM or non-REM sleep patterns. Thus, the sleep problems of shift workers are partly a circadian one (Ohayon, *et al.*, 2002). Four recent studies confirm sleep disturbances among shift workers including frequent insomnia, frequent use of hypnotics, sleep deprivation and daytime sleepiness (Khaleque, 1999, Nicholson and D'Auria, 1999, Garbarino, *et al.*, 2002, Ohayon, *et al.*, 2002). This is most noticeable after the night shift. The quantity of sleep may be reduced by up to two hours a day but there is also an effect on the quality of sleep. REM sleep and Stage 2 sleep have been shown to be reduced (Akerstedt, 1990). Such sleep deficits can lead to sleepiness and inadvertent napping at work which consequently might result in errors and accident occurrence at work. However, it should be noted that other factors are also involved in the deterioration of sleep quality such as fatigue, noisy surroundings, stress, daylight, health and age of workers (Khaleque, 1999, Ohayon, *et al.*, 2002).

Although gastrointestinal symptoms are very common in the general population, it was more common in shift workers than in day workers (Segawa, *et al.*, 1987, Scott and LaDou, 1994). In the long term, many shift workers may suffer serious diseases such as chronic gastritis, gastroduodenitis, colitis and peptic ulcer. The prevalence of peptic ulcer has been estimated to be two to five times higher among shift workers with night shifts, compared to day workers or shift workers without night shifts (Costa, 1996). Meal times are important synchronizers of the human life. They have both physiological and social contents; therefore they represent a crucial point of the worker's life. The work schedule and schedule-related changes in eating can interfere with gastrointestinal function because of inadequate timing of food intake with respect to the optimal

circadian phases of gastric secretion and enzyme activity. Food quality, which is poor during some shift and increased use of caffeine, nicotine or alcohol may result in additional interference (Costa, 1996, Garbarino, *et al.*, 2002).

As association of risk of coronary heart disease (CHD) and shift work is concerned, most of the studies on cardiovascular disease (CVD) among shift workers found that they were at increased risk of developing the disease (Akerstedt, *et al.*, 1984, Knutsson, *et al.*, 1986, Kawachi, *et al.*, 1995, McNamee, *et al.*, 1996, Nakamura, *et al.*, 1997, Boggild, *et al.*, 1999, Knutsson, *et al.*, 1999, Murata, *et al.*, 1999, Amelsvoort, *et al.*, 2001, Karlsson, *et al.*, 2001).

Table 1.1 shows a summary of a number of studies on shift work and cardiovascular disorders. The relative risk for ischaemic heart disease (IHD) in shift workers was accepted to be around 1.4 (Nicholson and D'Auria, 1999). Causal mechanisms are not well defined but contributing factors include disruption of circadian rhythm, disturbed sociotemporal patterns and social support, stress, smoking, poor diet, and lack of exercise (Harrington, 2001). Some researchers have postulated that the increased risk of developing the disease is the result of shift work inducing increased secretion of stress hormones while changing the factors such as blood pressure, heart rate, coagulation and lipid and glucose metabolism (Garbarino, *et al.*, 2002).

Table 1.1 Summary of studies on shift work and cardiovascular disorders

Author	Year	Number of sample	Ass	Study	RR/OR	Method
Thiis-Evensen	1958	14,308	No	Morbidity, manual workers		ce-in-q
Aanonsen	1959	1,106	No	Morbidity, manual workers		ce-is
Leuliet	1963	564	No	Morbidity, 12-yr follow-up		ce
Taylor & Pocock	1972	8,603	No	Mortality, 13 years		dc
Koller *et al.*	1978	270	Yes	White/blue collar complaints		q-in
Angersbach *et al.*	1980	640	No	Morbidity, retrosp., cohort		mr-is
Michel-Briand *et al.*	1981	200	Yes	In transferred shiftworkers		ce
Alfredsson *et al.*	1982	14,500	Yes	Myoc. infarction, national stats	1.26	db-is
Koller	1983	301	Yes	with increasing age		ce-in
Frees & Semmer	1986	3,446	Yes	In drop-outs		q
Knutsson *et al.*	1986	504	Yes	IHD, history prospect, 14 years	1.4	mr
Knutsson *et al.*	1988	601	Yes	Blue collars, risk factors		q-ce
Kawachi *et al.*	1995	79,109	Yes	CHD, women, 4-yr follow-up	1.38	mr-q-in
mc-Namee *et al.*	1996	934	No	Mortality, case-control, 42 yr	0.90	mr-db
Tenkanen *et al.*	1998	1,806	Yes	CHD, 6-yr cohort follow-up	1.30	ce-q
Knutsson *et al.*	1999	4,648	Yes	Men-women, case-control	1.3-3.0	mr-dc-q
Boggild *et al.*	1999	5,249	No	Men, prospect cohort, 22 years	0.96	ce-q

Legend (Methods):
ce = clinical examination; dc = death certificates; db = data banks; in = interviews; is = insurance records; mr = medical records; q = questionnaires; RR = Relative Risk; OR = Odds Ratio; Ass = Association
Adapted from a manuscript by Wedderburn (2000).

Few studies have reported that shift work might have an impact on metabolic variables and also be a risk factor for diabetes, although the evidence is not conclusive (Knutsson, 2003). Orth-Gomer (1983) studied the effects of a new rotation schedule on coronary risk factors on 45 volunteer policemen, demonstrated that the direction of shift rotation

could affect metabolic variables in which during clockwise shift rotation, serum triglycerides, glucose and uric acid were lower as compared to during counterclockwise rotation. Kawachi, *et al.* (1995) conducted a prospective study of shift work and risk of CHD in female nurses found that the age-standardized prevalence of diabetes increased with increasing exposure to shift work. A recent study by Nagaya, *et al.* (2002) examined the relationship between shift work and markers of insulin resistance (IR). They found that all markers of insulin resistance which include hypertension, diabetes mellitus, hypertriglyceridemia and hypo-high density lipoprotein-cholesterolemia which are collectively known as IR syndrome, were more common in shift workers than in day workers in the age group less than 50 years. A higher prevalence of obesity, hypertension, high triglyceride and low high density lipoprotein (HDL) but not hyperglycemia in shift workers than in day workers was also found in a population study (Karlsson, *et al.*, 2001). In addition, Romon, *et al.* (1992) reported that shift workers had significantly higher levels of triglycerides independent of dietary intake. Those results suggest that shift work may affect IR and may induce IR syndrome.

Irregular sleep schedules practiced by rotating shift workers may be of particular concern for workers with affective disorders (Scott and LaDou, 1994). Anxiety and depression indices point to the likelihood of an adverse effect on mental health from shift work and long working hours. Nevertheless, it must be remembered that shift workers are a self selected population. Thus, the question of whether shift work causes psychiatric morbidity or shift workers have pre-existent psychiatric problems is not entirely resolved (Harrington, 2001).

It should be recognized that the health impact of shift work depends to some extent on individual differences. There is a high inter-individual variability in tolerance to shift work. Aging may be associated with a progressive intolerance to shift work due to reduced psycho-physical fitness, the decreased restorative properties of sleep and a higher proneness to the internal desyncronization of circadian rhythms. On the other hand, younger people can find it difficult to adapt to night work either because they are more sensitive to acute sleep loss or because it hampers their possibility of participating and integrating with social groups (Costa, 2003). The ability to sleep at unusual times or known as flexibility and the ability to overcome drowsiness or vigor are two other examples of personality variables that predict shift work tolerance (Costa, *et al.*, 1989). In addition, it was shown that less favourable living and social conditions, which are often connected with both poor working conditions and long working hours, may aggravate the impact of shift work on health (Ong and Kogi, 1990).

The term shift work maladaption syndrome (SMS) has been used to describe the typical constellation of signs and symptoms seen in shift work intolerant workers. The symptoms and signs of SMS include sleepiness or sleeping at work, decreased vigilance, irritability and depression. In SMS, the symptoms are pronounced and worsen with continued exposure to shift work. The longer the worker stays on shift work, the worse the symptoms become, and eventually, the worker may be fired, quit his job or be involved in an accident (Scott, 2001).

To minimize ill-health that may result from shift work, periodic checks are important tools. They aimed at detecting early signs of difficulty in adjustment or intolerance that may require prompt intervention both at the organizational and the individual level. The

periodicity of the health checks should be set in relation to the various factors related to both working conditions such as shift work and individual characteristics such as age. As a general guideline, it is advisable to plan a second health check during the first year of shift or night work which is crucial for adaptation and coping, and successive health checks at least every three years for those under 45 years of age and every two years for those over 45 years old (Costa, 2003).

It is found that health problems due to the work schedule is a common reaction for workers to give up shift work (Scott and LaDou, 1994). Although there is a link between shift work and ill health, understanding of this association, including its direction and strength, is weak (Taylor, *et al.*, 1997).

1.3. Overview of Shift Work and Health in Malaysia

There are about 8.6 million workers in Malaysia which represents approximately 38.7% of the total population. The largest employers are the manufacturing sector (22.2%), followed by community, social, and personal services (20.1%), and wholesale, retail trade, hotel and restaurants (18.9%) (Rampal, *et al.*, 2002).

Shift work system is receiving priority attention in Malaysia as it has been practiced in United States and Europe. It is because of the concerns of productivity, health and safety. Rapid industrialization has introduced various types of working schedules and working hours as opposed to the conventional dawn-to-dusk practice. It is estimated that one-third of the present Malaysian workforce work abnormal hours of some type such

as shift work, some form of regulated scheme and staggered working hours (Chee and Rampal, 2003).

Shift work is common in the manufacturing sectors including electronics and textile industries, while the three-shift system is a rule in essential services and service industries. One local study which examined on the relationship between selected health problems and exposures among women semiconductor workers, found that majority of the workers in Malaysia were on rotating eight-hour shift (60.6%), whereas 30.1% were on a rotating 12-hour shift and others were on fixed shift (Chee and Rampal, 2003). Most Malaysian shift workers are men, but with rapid industrialization more women are being employed in shift work. Majority of these women are young, school leavers or dropouts, usually coming from rural areas attracted to work in urban areas (Mahathevan, 1982).

As far as Malaysian legislation is concerned, although it does not contain any provisions on the scheduling of working hours, Malaysian Employment Ordinance 1955 specifically states that women and workers below the age of 16 years should not work after 10.00 p.m. or before 7.00 a.m. In other words, night work is in principle forbidden in these two groups except with special and expressed permission of the Minister of Labour.

A preliminary study was done by the Occupational Health Unit of Ministry of Health (MOH) in a textile industry situated about 60 kilometres from Kuala Lumpur. The total workforce in the factory was 356 with 301 females and 55 males. Two hundred and eighty eight of the females did shift work when compared to only 33 of the males doing

shift work. The medical complaints from shift workers are shown in Table 1.2 below. Fatigue (95.8%) was the most frequent complaint followed by indigestion (92.0%) (Mahathevan, 1982).

Table 1.2 Medical complaints of workers interviewed

Complaints	Number of workers	Percentage
Fatigue	276	95.8
Indigestion	265	92.0
Leg and foot cramps	176	61.1
Menstrual irregularities	167	58.0
Insomnia	126	43.8
Chest pain	35	12.2
Nervousness	173	60.1
Fever off and on	90	31.3

Adapted from Mahathevan (1982)

1.4. Definition and Epidemiology of Cardiovascular Disease

CHD, also called coronary artery disease (CAD), is a condition that affects arterial blood vessels responsible for delivering blood, oxygen, and other nutrients to the heart muscle itself. CHD is the end-product of a pathogenic process associated with development of atherosclerotic plaque in the coronary vasculature, which is known as atherosclerosis (Samar, 1999). CHD covers a group of clinical syndromes which include angina pectoris, myocardial infarction and sudden cardiac death. It is one of the lifestyle-related diseases (Lorimer, 1997).

Cardiovascular disease (CVD), mainly comprising coronary heart disease (CHD) and stroke now ranks as the world's top cause of death, causing one third of all deaths

globally. Its prevalence varies between different populations and is influenced by a large number of hereditary and environmental factors. Since 1990, more people have died from CHD than from any other causes. It kills more than seven million people each year and most of deaths were in developing countries. In fact, it is on the rise and has become a true pandemic that respects no borders (WHO, 2004).

Death rates from CHD decreased in North America and many western European countries. This decline has been due to improved prevention, diagnosis and treatment, in particular reduced cigarette smoking among adults and lower average levels of blood pressure and blood cholesterol. It is expected that 82% of the future increase in coronary heart disease mortality will occur in developing countries (WHO, 2004). The increase is partly a result of increased longevity, urbanization and lifestyle changes.

CHD is not only a major cause of mortality but also of morbidity and rising health care costs. The costs of cardiovascular disease are diverse. They include the cost to the individual and to the family (of health care and time off work), the cost to government (of health care) and the cost to the country (of lost productivity). As an indication to the total burden of the disease, CVD is responsible for 10% of disability-adjusted life years (DALYs) lost in low- and middle-income countries and 18% in high-income countries. In addition, global CHD burden is increasing. It is projected to rise from around 47 million DALYs in 1990 to 82 million in 2020 (WHO, 2004).

In particular, heart diseases and diseases of pulmonary circulation are the commonest causes of mortality in Malaysian government hospitals, accounting to 16% of all deaths for the year 2001. CHD is the major cause of these deaths (MOH, 2003). In 2003,

DALYs lost per 1000 population of Malaysia as a result of heart disease was eight. Whereas, the number of deaths due to heart disease in the year 2002 was 13,445 (WHO, 2004).

1.5. Risk Factors for Coronary Heart Disease

The major established risk factors must meet three criteria which are a high prevalence in many populations, a significant independent impact on the risk of CHD and their treatment and control result in reduced risk (WHO, 2004). Epidemiological studies have identified the major independent risk factors for CHD to include cigarette smoking of any amount, elevated total cholesterol (TC) and elevated low-density-lipoprotein cholesterol (LDL), elevated blood pressure, low high-density-lipoprotein cholesterol (HDL), diabetes mellitus and advancing age. The predictive power of each of these major risk factors in determining an individual's global risk for CHD, is additive. An individual with more risk factors is at higher risk of developing atherosclerotic disease (Expert Panel, 2001). Approximately 75% of CVD can be attributed to those conventional risk factors (WHO, 2004).

In addition, there are other types of risk factors that have been associated with an increased risk of CHD. These are the predisposing risk factors and the conditional risk factors. Predisposing risk factors are those that worsen the risk associated with the independent risk factors. These are obesity, abdominal obesity, family history of premature CHD (male sibling or parent with CHD < 55 years and/or female parent or first degree relative with CHD<65 years), ethnic origin, psychosocial factors and

physical inactivity (Expert Panel, 2001). Worldwide, physical inactivity causes about 1.9 million deaths, 20% of CVD and 22% of CHD (WHO, 2004).

Conditional risk factors are associated with an increased risk for CHD although their causative and independent contributions to CHD have not been well documented. Those risk factors include elevated serum triglycerides, elevated serum homocysteine, elevated serum lipoprotein (a), prothrombotic factors (e.g. fibrinogen) and inflammatory markers (e.g. C-reactive proteins) (Expert Panel, 2001).

In developed countries, at least one-third of all CVD is attributable to five risk factors which are tobacco use, alcohol use, high blood pressure, high cholesterol and obesity. Similarly, in developing countries with low mortality, such as China, cardiovascular risk factors also figure high on the top-ten list. These populations face a double burden of risks, grappling with the problems of under-nutrition and communicable diseases, while contending with the same risks as developed nations. Even in developing countries with high mortality, such as those in sub-Saharan Africa, high blood pressure, high cholesterol, tobacco and alcohol use already figure among the top risk factors (WHO, 2004).

1.6. Justification of Study

This study is designed to investigate the association between shift work and certain risk factors for CHD which are high blood pressure (BP), dyslipidaemia, diabetes mellitus, obesity and physical inactivity among male factory workers. Since there was no

documented such study done previously in Malaysia as well as there was lack of data pool on effect of shift work particularly on CHD risk factors, the results of the study will hopefully provide useful information for the prevention of CHD among the shift workers.

In addition, work environment is increasingly becoming a subject of epidemiological studies. Working irregular hours, including night work and shift work, for example, has been found to be associated with various health problems caused by the disturbance of the biological rhythms. It includes sleep disorders, gastrointestinal disturbances and cardiovascular implication such as increased risk of ischemic heart disease.

Many researchers worldwide have investigated the risks to CHD among shift workers. Many of them have reported that there is an association between shift work and risk of developing CHD as compared to day workers. On the other hand, there is limited data on such study in Malaysia. This study provides scientific data pertaining to the effect of shift work on cardiovascular system especially among Kelantanese factory workers.

On top of that, there are almost 10 million of manual workers in our country among whom, most of them do shift work and they tend to be exposed to various health problems. Those workers contribute a great deal in supporting our economic growth. Hence, the risks of CHD among them should be studied and efforts should be administered to minimize such risks.

CHAPTER TWO

OBJECTIVES

2.1. General Objective

To determine whether there are relationships between shift work and risk factors to coronary heart disease which are dyslipidaemia (either hypercholesterolaemia, hyper-low density lipoprotein-cholesterolaemia, hypo-high density lipoprotein-cholesterolaemia or hypertriglyceridaemia), high body mass index (BMI), high BP, diabetes mellitus (DM) and physical inactivity among male shift workers as compared to male day workers in a factory in Kota Bharu, Kelantan.

2.2. Specific Objectives

2.2.1. To compare the prevalence of CHD risk factors (hypercholesterolaemia, hyper-low density lipoprotein-cholesterolaemia, hypo-high density lipoprotein-cholesterolaemia, hypertriglyceridaemia, high BMI, high BP, DM and physical inactivity) between the male population of shift workers and day workers in a factory in Kota Bharu, Kelantan.

2.2.2. To examine the association between shift work and high BP (as a risk to CHD) among male workers in the same factory.

2.2.3. To examine the association between shift work and dyslipidaemia (as a risk to CHD) among male workers in the factory.

2.2.4. To examine the association between shift work and high BMI (as a risk to CHD) among male workers in the factory.

2.2.5. To examine association between shift work and DM (as a risk to CHD) among male workers in the factory.

2.2.6. To examine association between shift work and being physically inactive (as a risk to CHD) among male workers in the factory.

2.3. Hypothesis

2.3.1. There are differences in the prevalence of CHD risk factors among shift male workers as compared to day male workers.

2.3.2. There is an association between shift work and high BP (as a risk to CHD) among those workers.

2.3.3. There is no association between shift work and dyslipidaemia (as a risk to CHD) among those workers.

2.3.4. There is an association between shift work and high BMI (as a risk to CHD) among those workers.

2.3.5. There is no association between shift work and DM (as a risk to CHD) among those workers.

2.3.6. There is an association between shift work and being physically inactive (as a risk to CHD) among those workers.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Study Design

This study was a cross-sectional study. It was designed to investigate the effect of shift work on risk factors for coronary heart disease. Risk factors which were investigated include hypercholesterolaemia, hyper-low density lipoprotein-cholesterolaemia, hypo-high density lipoprotein-cholesterolaemia, hypertriglyceridaemia, high body mass index, high BP, diabetes mellitus and physical inactivity among male factory shift workers as compared to male day workers.

This study was carried out in a factory located in Pengkalan Chepa, Kota Bharu, Kelantan, about nine kilometers away from Universiti Sains Malaysia. This premise was established in 1989. It specializes in the manufacturing of semiconductors and related components. The products lineup include monolithic integrated circuits (ICs), power modules, photo link modules, transistors, diodes, light emitting diodes (LEDs), laser diodes, resistors, capacitors, liquid crystal displays (LCDs), thermal heads, image sensor heads and LED displays. Total building area is 38,689 square meters and total land area is 83,891 square meters. It has a total of 980 employees, running 24-hours with two shifts. The shift system is as follows: first shift workers work from 0800H to 2000H whereas the second shift workers work from 2000H to 0800H. Shift rotation was as follows: DD-NN-OO-DD-NN-OO- and so on (D= day, N= night, O= off from working).

This study was designed as a cross-sectional study because of time constraint. The effect of shift work on CHD risk factors is a very long process. Since that, prospective study is not possible for a dissertation project. The study was conducted from 1st December 2003 to 31st May 2004.

3.2. Reference and Source Population

Reference and source population were all male workers at the selected factory (Figure 3.1).

3.3. Sampling Frame

The study involved all registered male workers who practiced shift and non-shift work (Figure 3.1). There were 620 male workers in the factory. Among those male workers, 450 of them did shift work and 170 did day work. Shift workers were among process operators, whereas day workers were among process operators, maintenance men and administrative workers. Inclusion and exclusion criteria were used to form the sampling frame.

3.4. Study Subjects

Subjects for each group of workers were selected through a simple random sampling method (Figure 3.1). We could not run a screening to exclude those who do not fulfill the inclusion criteria such as having chronic illnesses like diabetes mellitus, hypertension, dyslipidaemia or any cardiovascular diseases (to minimize healthy worker effect). It was due to the factory's rules and regulations. In view of the possibilities of selecting those who do not fulfill the criteria, we over-sampled the workers. The over-sampling was based on the overall prevalence of hypertension in Kelantan which was 14% (Mafauzy, *et al.*, 2003).

Those who did not fulfill the inclusion criteria as in section 4.6 and 4.7 were not included in the analysis. The exclusion of subjects was done when they answered "Ya" to a question on "Adakah anda pernah disahkan menghidap penyakit diabetes mellitus/kencing manis atau darah tinggi atau masalah lemak berlebihan atau masalah jantung?" in the self-administered questionnaire (Appendix E).

3.5. Research Framework

Figure 3.1 shows our research framework in the selection process of subjects into the study.

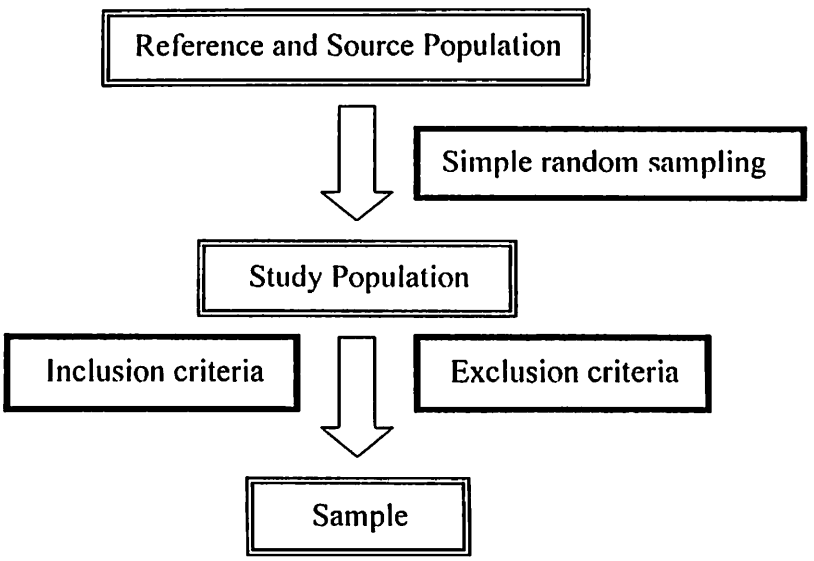

Figure 3.1 Research Framework of Reference and Source Population, Study Population and Sample

3.6. Inclusion Criteria

A worker was selected as a study subject when he fulfilled the following criteria:

1. One who is doing shift work or day work only
2. A worker whose age ranges from 19 to 50 years
3. Malaysian citizen
4. One who has been working for more than a year (Romon, *et al.*, 1992)
5. Male worker

3.7. Exclusion Criteria

A subject was excluded to be a sample when he fulfilled the following criteria:

1. One who has changing working schedules, for example from shift work to day work or vice versa
2. A worker with any known chronic illnesses such as diabetes mellitus, hypertension, dyslipidaemia or any cardiovascular diseases (to minimize healthy worker effect since employer tend to put those 'unhealthy' workers into day work)

3.8. Sample Size

The sample size was calculated for each objective. The largest and feasible sample size was from the high triglyceride (> 1.7 mmol/l) variable (Karlsson, *et al.*, 2001) with the specified level of significance (α) at 0.05 and power of the study (1-β) as 80%.

As found by Karlsson, *et al.* (2001), the proportion of high triglyceride among day workers was 0.1 and the proportion of high triglyceride among shift workers was specified as 0.3 (with detectable difference of 20%). The ratio of non-shift to shift workers was taken as one.

The formula used for sample size calculation was as followed:

Sample size for each group, $n = \dfrac{\{P_1(1-P_1)+P_2(1-P_2)\}(Z_\alpha + Z_\beta)^2}{(P_1-P_2)^2}$