ORIGINAL ARTICLE

Lipid Disorders Among Male Factory Shift Workers in Kota Bharu, Kelantan

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SUMMARY

Shift work is associated with various health problems and there is concern that shift workers are at higher risk to develop dyslipidaemia. A cross-sectional study was conducted from December 2003 to May 2004 to compare the prevalence of dyslipidaemia (hypercholesterolaemia, hypertriglyceridaemia, hyper-LDL and hypo-HDL-cholesterolaemia) and to examine the relationship between shift work and dyslipidaemia among 148 randomly selected male workers from one of the factories in Kota Bharu, Kelantan. Information on psychosocial and life-style factors, anthropometric and blood pressure measurement, fasting blood sugar and lipid profiles analyses were obtained. In multiple variable analysis, the presence of any abnormalities in the lipid profiles was regarded as having dyslipidaemia. The prevalence of hypercholesterolaemia (47.4%) and hypertriglyceridaemia (42.1%) were significantly higher among shift workers compared to day workers with p-value of 0.014 and 0.044 respectively. There was no significant different in the prevalence of hyper-LDL and hypo-HDL-cholesterolaemia and shift work was not significantly associated with dyslipidaemia, OR_{adj} = 1.27; 95% CI 0.63-2.57.

KEY WORDS:
Shift work, Dyslipidaemia, Prevalence

INTRODUCTION

Shift work involves a relay of employees, extending the period of production beyond the conventional 8-hour working day. Today, about one in five workers in Europe [1] and in the United States [2,3] are employed on shift work. 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 [1].

In Malaysia, shift work system is receiving priority attention as it has been practiced in United States and Europe because of the concerns of productivity, health and safety. Rapid industrialization leads to introduction of 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 [4].

In the literature, shift work has been found to be associated with various health problems which not only affect workers but also the economic and industrial sectors. Disturbance of workers' normal biological, or social diurnal rhythms, or both, cause health problems of shift workers [1,5,6]. Most human functions have a rhythm, the peaks and troughs of which occur in approximately a 24-hour period, known as circadian rhythms. These rhythms 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[7]. 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 follow circadian rhythms [3]. 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 [8].

A recent study found that all markers of insulin resistance (IR) which include hypertension, hyperglycemia, hypertriglyceridemia and hypo-High Density Lipoprotein-cholesterolemia were more common in shift workers than in day workers in the age group less than 50 years[9]. A higher prevalence of hypertriglyceridaemia and low HDL among shift workers than day workers were also found in a population study [10]. In addition, Romon, *et al.* [11] reported that shift workers had significantly higher levels of triglycerides independent of dietary intake. 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[1].

Since there was no documented such study done previously in Malaysia as well as lack of data pool on effect of shift work particularly on lipid disorders, this study was designed to compare the disorders prevalence (hypercholesterolaemia, hyper-LDL-cholesterolaemia, hypo-HDL-cholesterolaemia and hypertriglyceridaemia) between shift and day factory workers and to investigate whether shift work is associated with dyslipidaemia.

There are almost ten million of manual workers in our country. Most do shift work and they tend to be exposed to various health problems. These workers contribute a great deal in supporting our economic growth. Hence, the risks of dyslipidaemia among them should be studied and efforts

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should be administered to minimize such risks. The results of the study will provide useful information for the prevention of lipid disorders among shift workers.

MATERIALS AND METHODS

Study design

We conducted a cross-sectional study in a factory with 980 employees located in Pengkalan Chepa, Kota Bharu, Kelantan from December 2003 to May 2004. The factory manufactures semiconductors and related components. It runs 24-hours with two shifts. The first shift workers work from 8.00am to 8.00pm (considered as daytime) whereas the second shift workers work from 8.00pm to 8.00am (considered as night time). Shift rotation was as follows: DD-NN-OOO-DD-NN-OOO- and so on (D= daytime, N= night time, O= off from working).

Selection of participants

We selected the participants through simple random sampling. The list of workers gained from the factory's manager was the sampling frame and we used random table to identify the participants. A worker was eligible when he fulfilled the following criteria: Malaysian nationality within the age range from 19 to 50 years and had been working for more than a year in the factory. A subject was excluded if he had changing working schedules, for example from shift work to day work or vice versa, or having any known chronic illnesses such as diabetes mellitus, hypertension, dyslipidaemia or any cardiovascular diseases. We excluded these participants to minimize healthy worker effect since employers tend to put those 'unhealthy' workers into day work. These were determined from the subject's information sheet answered by them.

Sample size

The largest and feasible sample size was from the high triglyceride (> 1.7 mmol/l) variable[10] with the specified level of significance (α) at 0.05 and power of the study (1-β) as 80%. 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 day to shift workers was taken as one.

Total sample size for each group including 20% non-response and 14% over-sampling was 80. Cases of non-response were such as refusing from blood taking and declining to participate before end of study.

A total of 160 subjects were selected. However, seven subjects were dropped from the study because of not fulfilling the inclusion criteria and five did not finish the study. Those who did not fulfill the inclusion criteria were not included in the analysis.

Ethical approval

The study protocol was reviewed and presented to the Research Ethics Committee, School of Medical Sciences, Universiti Sains Malaysia on 24th September 2003 and was approved on 5th November 2003 (Ref. No.: USM/PPSP®/Ethics Com./2003(113.3[1]).

Research instruments

1. Subjects Information Sheet

Each subject answered a Malay language Subjects Information Sheet which consisted of three parts which were demographic data, smoking habit and physical activity. Shift workers were determined if he answered his type of work as "shift work" in the information sheet. Based on one of our local studies[12], physical activity was graded as active if a subject engaged himself in a sporting activity for at least three times a week; and each activity should be lasting for at least 15 minutes. Otherwise, physical activity was graded as inactive.

2. WHO Standard Physical Examination

Height and weight of the subjects were measured to the nearest tenth of a centimeter and nearest tenth of a kilogram respectively. These were done with the participants wearing light clothing and their shoes removed. Their weight was measured using a validated and calibrated bathroom spring balance. Their height was measured using a measuring tape which was attached to a rigid wall. During height measurement, their heels were close together and the subjects were asked to look horizontally ahead. Body mass index (BMI) was calculated and high body mass index was defined by BMI ≥ 25 kg/m^2.

Systolic and diastolic blood pressures were measured twice using an 8 times 14cm cuff of a standard mercury sphygmomanometer. The average of the two readings for both systolic and diastolic pressures was recorded for data analysis. The measurement was taken with each subject sitting on a chair after at least five minutes of rest. Hypertension was defined as the mean systolic blood pressure (SBP) ≥ 140 mmHg or mean diastolic blood pressure (DBP) ≥ 90 mmHg

3. Blood collection

For each subject, a ten hours overnight-fasting blood specimen was drawn from antecubital vein between 8.00am and 9.00am the day after. Blood for fasting lipid profile (FLP) was analyzed using calibrated chemistry analyzer (Hitachi 912) at the USM laboratory. Fasting blood sugar was obtained using a calibrated glucometer (Accutrend).

Hypercholesterolaemia was defined by a fasting serum total cholesterol level ≥ 6.22 mmol/l, hypertriglyceridaemia if fasting serum triglyceride level ≥ 1.70 mmol/l, hypo-HDL-cholesterolaemia if fasting serum HDL level ≤ 1.04 mmol/l and hyper-LDL-cholesterolaemia if fasting serum LDL level ≥ 4.14 mmol/l based on the Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults [13]. The presence of any abnormality stated above was regarded as having dyslipidaemia.

Hyperglycemia determination was based on WHO criteria. Fasting blood sugar level of more than 6.10 mmol/l was regarded as abnormal (hyperglycemia).

Statistical Analysis

Data was entered, cleaned and analyzed using SPSS version 11.0. STATA version 7 was used to determine the model fitness during logistic modelling. Descriptive analysis determined the comparability between the two groups. In

multivariable analysis, multiple logistic regression was used to detect an association between shift work and dyslipidaemia after adjusting for other variables. Fitness of the model was assessed using Hosmer-Lemeshow goodness-of-fit test, classification table and Receiver Operating Characteristics (ROC) curve. The model was further checked for model diagnostics by influential statistics with residuals plotted against predicted probability. The adjusted odds ratio (OR_{adj}) was estimated with 95% confidence interval (95% CI). A p-value of less than 0.05 was judged to be statistically significant.

RESULTS

A total of 148 subjects were selected for our study, with 76 (51.4%) of them being shift workers and 72 (48.6%) day workers.

Table I shows the main characteristics of shift and day workers. The age of the workers who participated in the study ranged from 20.1 years to 49.2 years and their working duration was from one to fourteen years. There was no significant difference in the mean age and duration of employment between the two worker groups (p = 0.369). Ex-smokers or non-smokers comprise about 63% and 61% of the shift and day workers respectively. There was no significant difference in the proportion of smokers among shift workers (36.8%) as compared to among day workers (38.9%).

Table III shows a final model for dyslipidaemia with the independent variables. Simple and multiple logistic regression analysis were conducted with presence or absence of dyslipidaemia as a dependent variable and type of work (shift work or day work) and other controlling variables as independent variables. We examined all possible confounders in the model during variable selection process. These variables were age, working duration, education level, marital status, nature of job, working hour (either 48 hours in a week or less or more than 48 hours in a week), smoking habit, BMI (either high or normal), presence of high blood pressure and physical activity (either active or inactive). After controlling for possible confounders, we found that there was no association between shift work and dyslipidaemia. There was no multicollinearity detected. All possible two-way or first order interactions, between type of work and other independent variables were checked, with none of them being significant in our model.

DISCUSSION

This study attempts to determine the relationship between doing shift work and odds of having dyslipidaemia. This study may not be a representative of all types of factory workers but it may for factories with shift work practice. Both shift work group and day work group were comparable with their mean age, working duration and marital status between shift and day workers being not significant.

Table I: Characteristics of 76 shift workers and 72 day workers

Variable	Shift workers		Day workers		p-value*
	Mean (SD)	No. (%)	Mean (SD)	No. (%)	
Age	31.6 (4.73)		32.32 (4.61)		0.369†
Working duration	8.8 (4.00)		8.12 (4.38)		0.350†
Income	982 (394.1)		1753 (624.8)		<0.001
Level of education:					
Secondary		67 (88.1)		24 (33.3)	<0.001
Tertiary		9 (11.8)		48 (66.7)	
Marital status:					
Married		59 (77.6)		64 (88.9)	8 (11.1)
Unmarried		17 (22.3)		64 (88.9)	
Nature of job:					
Machine assisted		61 (80.2)		11 (15.3)	<0.001
Manual		12 (15.8)		11 (15.3)	
Supervisory		3 (3.9)		50 (69.4)	
Smoking habit:					
Current smoker		28 (36.8)		28 (38.9)	0.613
Ex-smoker		12 (15.8)		15 (20.8)	
Never smoked		36 (47.4)		29 (40.3)	
Smoking duration among smokers (year)	12.1 (4.86)		10.6 (4.23)		0.234
Tobacco smoked per day among smokers	8.21 (3.28)		9.2 (4.68)		0.376

(SD) : standard deviation
* Pearson Chi-square test
†Independent t test

Table II: Prevalence of risk factors for CHD in shift and day workers

Risk factor	Shift workers *n=76*	Day workers *n=72*	P value
	No. (%)	No. (%)	
Hypercholesterolaemia[a]	36 (47.37)	20 (27.78)	0.014
Hyper-LDL-cholesterolaemia[b]	29 (38.16)	22 (30.56)	0.331
Hypo-HDL-cholesterolaemia[c]	7 (9.21)	10 (13.89)	0.372
Hypertriglyceridaemia[d]	32 (42.10)	19 (26.39)	0.044

[a]Fasting serum total cholesterol ≥ 6.22 mmol/l
[b]Fasting serum LDL cholesterol ≥ 4.14 mmol/l
[c]Fasting serum HDL cholesterol ≤ 1.04 mmol/l
[d]Fasting serum triglyceride ≥ 1.70 mmol/l

Table III: Association of shift work and dyslipidaemia among 148 factory workers

Variables (n)	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)a	LR Stat.	p-value
Type of work					
Shift work (76)	1.37 (0.71-2.64)	0.345	1.27 (0.63-2.57)	0.46	0.498
Day work (72)	1.00	-	1.00		
Age	1.11 (1.03-1.20)	0.007	1.10 (1.01-1.19)	5.36	0.024
Body mass index					
High (48)	3.00 (1.40-6.43)	0.005	2.41 (1.08-5.34)	4.86	0.031
Normal (100)	1.00		1.00		

LR Stat.: Likelihood Ratio Statistic

In our study, level of education acted as a proxy for socioeconomic status. Low socioeconomic status is a potential confounder when studying the association between shift work and dyslipidaemia. We found that day workers were more educated as compared to shift workers, probably due to the selection of the subjects in our study. Day workers were selected from operators as well as from among white collar and administrative workers.

Studies on the prevalence of lipid disorders published in the occupational health literature over the last 30 years have inconclusive findings, probably attributed to the methods of studies used. We found that the prevalence of hypercholesterolaemia and hypertrigliceridaemia were significantly higher among shift workers compared to among day workers but not the prevalence of hyper-LDL and hypo-HDL-cholesterolaemia between the two groups studied.

In this study, we found a significant difference between the two groups of workers. It was higher among the shift workers (47.7%) than day workers (27.8%). Our finding was in contrast with a prospective study by Kawachi, *et al.*[14] who showed that the prevalence of hypercholesterolaemia between the two groups is almost similar which was 23%. A higher prevalence of hypertriglyceridaemia among shift workers than in day workers in our study was consistent with two previous cross-sectional studies [9,10]. The prevalence of hypertriglyceridaemia (42.1%) among shift workers in our study was higher compared to those in previous studies which were 30.8% and 31.3% respectively. The difference in the finding could be explained by the lower prevalence of hypertriglyceridaemia in their general population than that in our country.

Hypo-HDL-cholesterolaemia was not associated with effect of shift work in our study which is consistent with a study by Nagaya, *et al.*[9]. This may be due to the stability of serum HDL in contrast to other lipid markers. In a population study by Karlsson, *et al.*[10], shift workers had a higher prevalence of hypo-HDL-cholesterolaemia than day workers which was significant among workers aged 30-39 years and 50-59 years old. However, in the study there were no adjustments for nature of jobs or for lifestyle such as smoking. Adjustment is necessary because both shift work and smoking habit were generally more frequent in blue-collar workers than in office or white-collar workers. Results from the study may be confounded by factors such as smoking habit related to job and nature of their jobs.

In our study, there was no association between type of work and dyslipidaemia when the significant controlling variables, age and BMI were controlled. The cross-sectional study design of our study may underestimate chronic diseases due to selection effects. Managers tend to transfer those shift workers with any chronic illnesses to day work. Other explanations may be insignificant effects on lipid profiles at the current exposure, minimal or subtle change in their profiles or due to inadequate sample size to produce enough study power.

CONCLUSION

In conclusion, in the present factory male workers population, the prevalence of hypercholesterolaemia and hypertriglyceridaemia were higher among the shift workers. Shift work however was found not to be associated with dyslipidaemia. Important metabolic risk variables such as raised cholesterol and triglyceride concentrations are more common among shift workers which warrant attention from health care workers. Further research with better design and subject selection are necessary to establish association between shift work and dyslipidaemia.

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