J Occup Health 2005; 47: 89–95

Journal of Occupational Health

Shiftwork and Metabolic Risk Factors of Cardiovascular Disease

Mina HA[1] and Jungsun PARK[2]

[1]Department of Preventive Medicine, Dankook University College of Medicine and [2]Occupational Safety and Health Research Institute, Korea Occupational Safety and Health Agency, Korea

Abstract: Shiftwork and Metabolic Risk Factors of Cardiovascular Disease: Mina HA, *et al*. Department of Preventive Medicine, Dankook University College of Medicine, Korea—We conducted this study to examine the relationship between shift work duration and the metabolic risk factors of cardiovascular disease among shift workers. The study population consisted of 226 female hospital nurses and 134 male workers at a firm manufacturing diapers and feminine hygiene materials, whose mean ages were 28.5 yr for the nurses and 29.1 yr for the male workers. The fasting blood sugar level, serum cholesterol, blood pressure, height and weight, waist and hip circumferences (only for the nurses), and numbers of walks during work (as a measure of physical activity) were measured. Using the Karasek's job contents questionnaire, job stress was assessed. Information about the years of work, shift work duration, past medical and behavioral history, including smoking, was obtained by a self-administered questionnaire. With definitions of hypertension as systolic blood pressure (SBP) ≥160 or diastolic blood pressure (DBP) ≥90 mmHg occurring at least once, hypercholesterolemia as serum total cholesterol ≥240 mg/d*l*, obesity as body mass index (BMI) ≥25 kg/m^2 and as waist to hip ratio (WHR) ≥0.85, we examined the prevalences of metabolic risk factors among subjects. Regression analyses to show the relationships between shift work duration and metabolic risk factors were performed using simple and multivariate models stratified by age, and adjusted for smoking, drinking, job strain and physical activity. Duration of shift work was significantly associated with SBP or cholesterol level among male workers aged 30 or more. Among female nurses, it was inversely associated with DBP (in those who were below 30 yr old) and cholesterol (in those who were aged 30 or more). BMI was non-significantly associated with the duration of shift work in both male workers and female nurses who were 30 yr old or more. WHR in female nurses increased slightly according to increasing duration of shift work. Fasting blood sugar was not significantly associated with the duration of shift work in either sex regardless of age-group. These results suggest an association between shift work duration and the metabolic risk factors of cardiovascular disease. *(J Occup Health 2005; 47: 89–95)*

Key words: Shift work duration, Blood pressure, Obesity, Metabolic risk factor

The number of shift workers has increased in some branches of industry, especially manufacturing. The total number of night shift and other types of shift workers ranges from 15 to 20% of the total workforce in most European Community countries[1)], and is 20% in the United States[2)]. In Asian countries, the numbers of shift workers are gradually increasing, and it has been estimated that about 6% of the total work force in Thailand, 10% in the Philippines, and 14% in Peru were involved with shift work during the 1980's [3)]. Nationwide surveys showed the percentages of shift workers were 32% in Singapore (1991)[4)] and 25% in Korea (1994)[5)]. There have been several reports on the incidence of cardiovascular diseases (CVD) among shift workers. Most of these studies found significant associations between CVD and shift work[1, 6)]. The longer the shift work duration, the higher the risk of CVD[7)]. The population etiologic fraction of shift work on cardiovascular disease has been estimated to be approximately 7%, due to the high proportion of shift workers in the workforce[8)]. One of the mechanisms proposed for this association is a mismatch of circadian rhythms, through which metabolic disturbances could occur[9)].

A recent epidemiologic study reported that obesity, high triglycerides (TG) and low concentrations of high-density lipoprotein (HDL) cholesterol appear to cluster together more often in shift workers than in day workers[9)]. On the other hand, there is strong evidence showing that the metabolic syndrome, which is composed of obesity,

Received Dec 16, 2002; Accepted Nov 22, 2004
Correspondence to : M. Ha, Department of Preventive Medicine, Dankook University College of Medicine, San29 Anseo-Dong, Cheonan, Chungnam, 330-714, Korea
(e-mail : minaha@dankook.ac.kr)

dyslipidemia with high TG and low HDL cholesterol concentrations, hypertension, low fibrinolytic activity and often impaired glucose tolerance, is a risk factor for cardiovascular disease[10]. Therefore, association between shift work and the metabolic syndrome might explain the association between shift work and cardiovascular disease.

The purpose of this study was to investigate whether or not the duration of shift work is associated with the various metabolic disturbances that together constitute the metabolic syndrome.

Materials and Methods

1. Study population and questionnaire

This cross-sectional study population consisted of 226 female hospital nurses (189 registered nurses and 37 nurses' aides) and 134 male blue-collar workers at a firm manufacturing diapers and feminine hygiene materials. The nurses followed an 8-h irregular rotating work schedule. The starting times were 7:00 a.m. for the morning shift, 3:00 p.m. for the evening shift and 10:00 p.m. for the night shift. Instead of having a fixed mealtime, they ate during times that were less busy. Their work consisted of taking care of patients, assisting physicians with their work and updating medical charts. The male workers followed an 8-h short, rotating shift schedule (consisting of cycles of 3 d of work followed by 1 d of rest, with shift rotation occurring at the end of each cycle). The direction of rotation was counter-clockwise. The starting times of the different shifts were 8:00 a.m., 4:00 p.m. and 12 a.m. Each worker had two rest periods of about 10 min during each work shift. Due to the continuous nature of the production line, they had to take turns at resting rather than having a fixed resting time together. Their work involved operating various machines and correcting errors either manually or by computer. The male workers worked night shifts 10 times per month as a mean, while the female nurses worked 5 night shifts per month as a mean.

By a self-administered questionnaire, information about lifetime occupational history focusing on shift work experience and duration was obtained. Information about smoking status was also obtained through the questionnaire and was recorded in the form of current/ex/non smoker and pack-years of smoking. Information about drinking behavior was also obtained. From both the self-administered questionnaire and the database of health monitoring in the hospital and factory, information regarding the demographic factors, and past medical history, such as whether or not the subjects had been diagnosed as having any kind of disease by a physician within the past 5 yr, was obtained. The shift work duration was defined as the total number of months during which the person had engaged in shift work in his or her lifetime. Intensity of shift work (the number of shifts per month) was not considered in the present study. In the analysis, shift work duration was treated as the number of years; it was assessed in months and then converted to years. Meetings were held with each group of nurses and male workers to give presentations about the study's aims and method, and to encourage them to participate. The volunteers were asked to sign an informed consent statement that was included in the study questionnaire.

2. Metabolic risk factors

For each subject, the blood pressure (BP) was measured at about 12 p.m. or 4 p.m. with an automatic sphygmomanometer (TM2541, A&D Company, Ltd, Japan). In the case of the male workers, the 2nd or 3rd day of a normal 3-day morning or afternoon shift was chosen as the test day, while in the case of the nurses, the middle day of a morning or afternoon shift of irregular rotation was chosen. The BP was checked twice consecutively, while the subject was sitting down after 5 min. rest. The waist and hip circumferences were measured only in the case of the nurses. Height and weight were measured for both the male workers and the nurses, using a Martin's anthropometer and a digital weighing scale, respectively, according to the Standardization Reference Manual for Health Data Collection and Measurement[11]. Blood samples for checking the levels of serum cholesterol and glucose were taken after fasting for at least 6 h. Hypertension was defined as systolic BP greater than 159 mmHg or diastolic BP greater than 89 mmHg. As definitions of hypercholesterolemia and hyperglycemia, levels of blood cholesterol and blood glucose of more than 239 mg/d*l* and 124 mg/d*l* were chosen, respectively. Obesity was defined as a BMI of 25 kg/m^2 or more, or as a WHR of 0.85 or more[12].

3. Confounding factors: job stress, physical activity, drinking and smoking

As a confounding factor, job stress was assessed using Karasek's job contents questionnaire (JCQ) with 49 items translated into Korean[13]. JCQ is a questionnaire designed to measure workers' job stress using a job strain model composed of two axes which are defined as job-demand and decision latitude[14]. Job strain scales were obtained as decision latitude, psychological job demand, social support and job insecurity according to the method developed by the JCQ center[13]. As defined by the job strain model, the study subjects were classified into 4 groups consisting of low, passive, active and high strain subjects with the median of scores for both of each axis, job-demand and decision latitude. The number of steps was counted during the subjects' morning work-shift for a day with steppers as an indicator of physical activity.

The alcohol drinking behavior was classified into 4 categories defined as never/slight/moderate/heavy drinkers. A 'slight drinker' was defined as someone who

usually drank less than once a month or less than 1 glass (about 50 m*l*) of So-Ju (20–25% alcoholic concentration) on each occasion. 'Moderate' drinking was defined as a frequency of 3–5 times a month with the amount of less than 3 glasses of So-Ju on each occasion. Those who exceeded this 'Moderate' consumption level were classified as 'Heavy' drinkers.

Information about smoking status was obtained by means of the question, 'Have you ever smoked?' with the possible answers being never, ex- or current smoker. In the case of ex- or current smokers, there was an additional question to determine the pack-years of smoking. In the multivariate analysis, smoking status was controlled by categorizing smoking status (i.e. never, ex- or current smoker), only for the male workers, because the all female workers reported as being neither ex- nor current smokers.

4) Statistical analysis

To examine the association between the total number of years working shift periods and BP, the level of total cholesterol, fasting blood sugar, BMI and WHR, linear regression analyses were applied using a generalized linear model. The estimated values of the regression slopes, where the independent variable was 'shift work duration' and the dependent variables were the levels of BP, cholesterol, fasting blood sugar (FBS), BMI and WHR were calculated to show the linear relationships between them. All regression analyses were separately performed by age stratification with two categories (<30 and ≥30 yr) because the duration of shift work was closely correlated with age. To control certain confounding factors, multivariate linear regression analyses were done with job strain, smoking status and drinking behavior as categorical variables. Job strain, smoking status and drinking behavior were input as 4- or 3-category variables as mentioned above. Physical activity, the number of steps during the morning shift, was applied as a continuous variable in the models. The interactions among shift work duration and each confounding factor in the multivariate models were checked. No interaction terms were put into the multivariate models, because there were no interaction effects with statistical significance among them. We used SAS for Windows (v. 8.2) software with the generalized linear model (GLM) procedure.

Results

1. General characteristics of the study population

The mean shift work duration during past and present jobs was 2.8 yr (range: 1 month–10 yr) for the nurses and 5.2 yr (range: 5 months–10 yr) for the male workers. The shift work durations of the male workers were concentrated in the 4–6 yr range, as opposed to 1–2 yr for the female nurses (Fig. 1). Their mean ages were 28.5 (range: 19–49) yr for the nurses and 29.1 (range: 25–44) yr for the male workers. In the male workers aged below 30, more than 95% of the subjects were 25–29 yr old, but in the female nurses aged below 30, 21.3% were 20–24 yr old and 64.5% were 25–29 yr old. While 99% of the nurses were non-smokers, approximately 78% of the male workers were current smokers. According to Karasek's job strain model, the passive group comprised 50.6% of the male workers and 26.1% of the nurses, while the high strain group comprised 20.0% of the male workers and 29.2% of the nurses.

The number of subjects with a past medical history was 16 for the male workers and 18 for the nurses, and these subjects were excluded from the analysis, in order to avoid the possible overestimation of the results due to the inclusion of diseased persons whose illnesses were not related to shift work (Table 1). Among the male workers, there were 3 cases of hypertension, 2 of asthma, rhinitis, duodenal ulcer, and 1 each of tuberculosis, renal disease, hypelipidemia, intestinitis, chronic fatigue, gastritis, acute epididymitis, ureter stone, prostatitis and osteomyelitis. Among the nurses, there were 12 cases of iron deficient anemia, 3 of gastritis, 2 of allergic rhinitis and 1 of rheumatoid arthritis.

The higher the age of the subject, the longer was the duration of the shift work. These two factors showed a statistically significant correlation, both in the male workers (Pearson's coefficient=0.53, $p<0.05$) and the female nurses (Pearson's coefficient=0.52, $p<0.05$). In the female nurses, physical activity and shift work duration were inversely correlated (Pearson's coefficient=–0.14, $p<0.05$), which was probably due to the significant inverse correlation between physical activity and age (Pearson's coefficient=–0.32, $p<0.05$). In the male workers, there were no significant correlations between the shift work duration and physical activity, smoking or drinking status (Data not shown).

2. Prevalence of metabolic risk factors of cardiovascular disease among subjects

About 30% of the male workers but just 2.4% of the

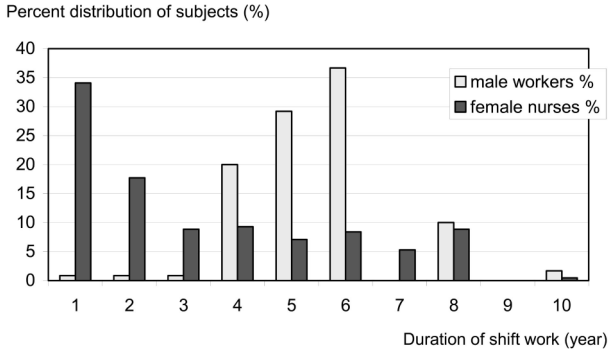

Fig. 1. Distribution of shift work duration of the subjects.

Table 1. Characteristics of study subjects

Variables		Male workers (n=134)	Female nurses (n=226)
		Mean (range)	
Shift work duration (yr)		5.2 (1–10)	2.8 (1–10)
Frequency of night shift per month		10.0 (8–13)	4.7 (1–8)
Age (yr)		29.1 (25–44)	28.5 (19–49)
Physical activity (number of steps)		8,686.9 (1,771–14,856)	7,678.0 (1,364–21,276)
	No. (%)		
Marital status	Non-married	56 (41.8)	140 (62.0)
	Married	77 (57.5)	85 (37.6)
	Bereaved	1 (0.7)	1 (0.4)
Past Medical History	No	118 (88.1)	208 (92.0)
	Yes	16 (11.9)	18 (8.0)
Smoking status	Non-smoker	18 (13.4)	224 (99.1)
	Ex-smoker	12 (9.0)	0
	Current smoker	104 (77.6)	0
	No response	0	2 (0.9)
Drinking behavior	Never-drink	7 (5.4)	50 (22.1)
	Slight	40 (31.0)	166 (73.5)
	Moderate	54 (41.9)	10 (4.4)
	Heavy-drinker	28 (21.7)	0 (0.0)
Job Strain	Low strain	21 (15.6)	56 (24.8)
	Passive	68 (50.6)	59 (26.1)
	Active	18 (13.8)	45 (19.9)
	High strain	27 (20.0)	66 (29.2)

Table 2. Prevalences of metabolic risk factors among subjects

Characteristics	Male workers (n=118)		Female nurses (n=208)	
	No.	(%)	No.	(%)
Hypertension[a]	36	(30.5)	5	(2.4)
Hypercholesterolemia[b]	3	(2.5)	7	(3.4)
Hyperglycemia[c]	0	(0.0)	0	(0.0)
Obesity by BMI[d]	33	(27.9)	6	(2.8)
Obesity by WHR[e]	–	–	15	(7.2)

a. Systolic BP ≥160 mmHg or diastolic BP ≥90 mmHg, b. Total blood cholesterol ≥240 mg/dl, c. Fasting blood sugar ≥125 mg/dl, d. Body Mass Index ≥25 kg/m^2, e. Waist to Hip Ratio ≥0.85

female nurses were classified as being hypertensive. Three male workers (2.5%) and seven female nurses (3.4%) were classified as having hypercholesterolemia. The obese persons were 27.9% of the male workers according to their BMI and 2.8% (according to BMI) or 7.2% (according to WHR) of the female nurses. There were no cases of hyperglycemia (Table 2).

3. Associations of shift work duration with metabolic risk factors

Significantly increasing trends in BP were observed with increasing shift work duration in the case of the male workers, but in female nurses aged less than 30, a significant inverse association was observed in DBP. While the male workers, in particular those of 30 yr old

Table 3. Linear regression of shift work duration on metabolic risk factors of CVD

Dependent variables \ Independent variable			Parameter estimates of Shift work duration[a]			
			Male workers		Female nurses	
		Age (year)	<30 (n=74)	≥30 (n=44)	<30 (n=142)	≥30 (n=66)
Blood Pressure	Systolic	Crude	1.65	4.14*	–1.07	0.32
		Adjusted[b]	2.75†	4.31*	–0.99	0.29
	Diastolic	Crude	2.92*	4.72*	–1.09*	–0.02
		Adjusted[b]	3.47†	3.90†	–1.01*	–0.10
Cholesterol		Crude	0.13	4.10	1.53	–2.17
		Adjusted[b]	1.44	9.72*	0.92	–2.82*
Fasting blood sugar		Crude	0.96	1.03	0.09	0.10
		Adjusted[b]	1.37	1.13	–0.12	–0.07
Body mass index		Crude	–0.09	0.39	0.00	0.03
		Adjusted[b]	–0.09	0.45	–0.03	0.02
Waist to hip ratio		Crude	–	–	0.00	0.005*
		Adjusted[b]	–	–	0.00	0.004*

a. The unit of shift work duration is years. b. Adjusted for smoking status, drinking behavior, physical activity and job strain in male workers, and for physical activity and job strain in female nurses. *$p<0.05$, †$p<0.1$.

or more, showed a significant positive association between cholesterol and shift work duration, the female nurses those of 30 yr old or more showed a significant inverse association between these two factors in the multivariate model. No association was observed between the FBS and shift work duration either in the male workers or in the female nurses. The BMI did not show any statistically significant association with shift work duration in either group. The WHR in the nurses of 30 yr old or more was significantly associated with shift work duration (Table 3).

Discussion

The metabolic syndrome, a concurrence of hypertension, dyslipidemia, hyperglycemia and central obesity, is a strong risk factor in cardiovascular disease[15]. The purpose of this study was to examine the association between shift work and factors related to the metabolic syndrome. The results for the male workers showed that BP and cholesterol levels significantly increased according to increasing shift work duration, especially in the group aged 30 or more. In the female nurses aged 30 or more, the WHR significantly increased, while the level of blood cholesterol decreased, according to increasing shift work duration.

There is much controversy surrounding the topic concerning the association between shift work and obesity[16]. Several recent studies reported associations consistent with those found in the present study. A cohort study in nurses reported a positive association between shift work and weight gain[17]. In the Copenhagen male cohort study, a positive association between shift work and weight gain was also observed[18]. Japanese blue collar shift workers showed a particularly high frequency of central obesity compared to day workers[19]. The amount of weight gain due to shift work was estimated as being 0.9 kg for every 5 yr of shift work duration by Neidhammer and colleagues[17], which is equivalent to 0.070 kg/m^2 (BMI) per year[20]. Other studies have reported increases in BMI per year of shift work of 0.098 kg/m^2 [21] and 0.120 kg/m^2 [19]. In the present study, the increases in BMI per year of shift work were 0.015 kg/m^2 for the female nurses aged 30 or more and 0.455 kg/m^2 for the male workers aged 30 or more. The estimated weight increase was higher in the male workers than in the nurses. This difference may be the result of the different occupational conditions. The hospital conditions or the nursing job itself might induce a healthier attitude and behavior on the part of the nurses. For instances, none of the nurses in the present study smoked cigarettes. Furthermore, the intensity of night shift (e.g., frequency of night shift a month) between the two groups was different.

One cohort study reported an association between shift work duration and the incidence of diabetes mellitus (DM)[21], while a cross-sectional study performed in Sweden did not reveal any difference in the prevalence of DM between day workers and shift workers[22];

however, these might be the results of a healthy worker effect. Those workers experiencing chronically ill health conditions tend to withdraw from their jobs or to convert to permanent daytime jobs, and this might produce a selection bias in the cross-sectional design. There was no significant association between the FBS level and shift work duration in the present study. One possible reason might be the fact that the duration of shift work was only 10 yr maximum, which might be too short to observe a distinct effect of shift work on FBS level. Furthermore, in female nurses, the FBS levels of adjusted models showed decrease without statistical significance according to the increase in duration of shift work. This might be evidence of a healthy worker effect in the nurses, whose turnover rate was very high, contrary to the increase effect for the FBS level without statistical significance in male workers, whose turnover rate was low.

Some studies have reported a positive correlation between total cholesterol, TG or low-HDL levels and shift work[12, 22]. In the present study, the male workers showed a significantly increased cholesterol level according to increasing shift work duration. The female nurses, however, showed an inverse relationship between blood cholesterol level and shift work duration in the group aged 30 or more. This might be further evidence of a healthy worker effect in the female nurses or reflect a different sex hormone effect on blood cholesterol[23], and/or simply be due to the fact that Korean women have 182 mg/d*l* of average blood cholesterol level, which is relatively low[24].

There has been a certain amount of controversy concerning the association between BP and shift work[12]. The male workers in this study showed a significant increase in SBP and DBP according to increasing shift work duration, but this was not the case for the nurses.

Overall, the results of the present study may provide supporting evidence for association between the metabolic risk factors of cardiovascular disease or metabolic syndrome and shift work. The limitation of the present study comes from the cross-sectional study design, in which the possibility of a healthy worker effect in the female nurses could not be excluded; the conceivable existence of a healthy worker effect would dilute the true associations. Also, this study was based on volunteer participants, and participation rates were 62.6% among male workers (134/214) and 94.1% among nurses (226/240). The volunteers might have had certain specific characteristics which differed in some way from those of the non-participants, thereby influencing on the estimated results. Finally, in spite of age having been adjusted by dichotomized stratification in this study, there might still remain a correlation effect between age and shift work duration because the ranges of age used were wide (more than 10 yr). Therefore, there is a need to confirm the association between the metabolic risk factors of cardiovascular disease or metabolic syndrome and shift work by means of a large-scale prospective cohort study.

Acknowledgments: The present study was supported by a grant from the Korea Research Foundation in 2000 (KRF-00-003-F00069).

References

1) L Tenkane, T Sjoblom, T Kalino, T Alikoski and M Harma: Shift work, occupation and coronary heart disease over a 6-years of follow up in the Helsinki Heart Study. Scand J Work Environ Health 23, 257–265 (1997)
2) Monk TH. Shift work. In: Kryger MH, Roth T, Dement WC, eds. Principles and Practice of Sleep Medicine. 2nd ed. Philadelphia: W.B. Saunders Company, 2000: 471–476.
3) CN Ong and K Kogi: Shiftwork in developing countries: current issues and trends. Occup Med 5, 417–428 (1990)
4) OY Chan and SL Gan: Shiftwork in Singapore. Singapore Med J 34, 33–37 (1993)
5) J Park, D Paek, K-B Lee, K-Y Rhee and K-H Yi: Shiftwork and sickness absence in Korean manufacturing industries. Korean J of Preventive Medicine 27, 475–486 (1994)
6) K Steenland and L Fine: Shift work, shift change, and risk of death from heart disease at work. Am J Indust Med 29, 278–281 (1996)
7) A Knutsson, T Akerstedt, B Jonsson and K Orth-gomer: Increased risk of ischemic heart disease in shift workers. Lancet 8498, 89–92 (1986)
8) T Akerstedt and A Knutsson: Cardiovascular disease and shift work. Scand J work Environ Health 23, 241–242 (1997)
9) A Knutsson and H Boggild: Shiftwork, risk factors and cardiovascular disease : review of disease mechanisms. Rev Environ Health 15, 359–372 (2000)
10) S Haffner. Epidemiology of insulin resistance and its relation to coronary artery disease. Am J Cardiol 84, 11J–14J (1999)
11) Korean academic society of preventive medicine. Standardization reference manual for health data collection and measurement. Kwang Ho Maeng ed. Seoul, Korea: Gechuk. 2000
12) WHO. Obesity, preventing and managing the global epidemic. In: Report of a WHO consultation on obesity. Geneva, Switzerland: WHO, 1998
13) R Karasek, C Brisson, N Kawakami, I Houtman, P Bongers and B Amick . The Job content Questionnaire(JCQ): An Instrument for Internationally Comparative Assessments of Psychosocial Job Characteristics. J Occup Health Psychol 3, 322–355 (1998)
14) Karasek R, Theorell T. Healthy work. New York, NY: Basic Books, 1990
15) G Assmann, P Cullen, F Jossa, B Lewis and M Manchini: Coronary heart disease: Reducing the risk: The scientific background to primary and secondary

prevention of coronary heart disease a worldwide view. Arterioscler Thromb Vasc Biol 19, 1819–1824 (1999)
16) H Boggild and A Knutsson. Shiftwork, risk factors and cardiovascular disease. Scand J Work Environ Health 25, 85–99 (1999)
17) I Neidhammer, F Lert and M-J Marne: Prevalence of overweight and weight gain in relation to night work in nurses' cohort. Int J Obes Relat Metab Disord 20, 625–633 (1996)
18) H Boggild, P Suadicani, HO Hein and F Gyntelberg: Shiftwork, social class and ischemic heart disease in middle aged and elderly men : a 22 year follow up in the Copenhagen male study. Occup Environ Med 56, 640–645 (1999)
19) K Nakamura, S Shimai, S Kikuchi, K Tominaga, H Takahashi, M Tanaka, S Nakano, Y Motohashi, H Nakadaira and M Yamamoto: Shiftwork and risk factors for coronary heart disease in Japanese blue-collar workers: serum lipids and anthropometric characteristics. Occup Med 47, 142–146 (1997)
20) LGPM van Amelsvoort, EG Schouten and FJ Kok. Duration of shiftwork related to body mass index and waist to hip ratio. Int J Obesity 23, 973–978 (1999)
21) I Kawachi I, GA Colditz, MJ Stampfer, WC Willet, JE Manson, FE Speizer and CH Hennekens. Prospective study of shift work and risk of coronary heart disease in women. Circulation 92, 3178–3182 (1995)
22) B Karlsson, A Knutsson and B Lindahl: Is there an association between shift work and having a metabolic syndrome? Results from a population based study of 27,458 people. Occup Environ Med 58, 747–752 (2001)
23) Meilahn E. Sex steroid hormonal influences on coronary artery disease. In: R Ness, L Kuller, eds. Health and disease among women: biological and environmental influence. New York: Oxford University Press, 1999.
24) YM Song, J Sung, JJ Byeon, JS Kim and OY Park: The relationship between cholesterol level and mortality in Korean women. Kor J Epidem 19, 131–146 (1997)