European Review for Medical and Pharmacological Sciences 2012; 16: 594-599

The effect of day and night shifts on oxidative stress and anxiety symptoms of the nurses

T. ULAS, H. BUYUKHATIPOGLU, I. KIRHAN, M.S. DAL[1], M.A. EREN, A. HAZAR[2], M.E. DEMIR, T. AYDOGAN, F. KARABABA[3], A. UYANIKOGLU, I.C. KURKCUOGLU[4]

Department of Internal Medicine, Faculty of Medicine, Harran University, Sanliurfa (Turkey)
[1]Department of Internal Medicine, Faculty of Medicine, Dicle University, Diyarbakir (Turkey)
[2]Department of Thoracic and Cardiovascular Surgery, Faculty of Medicine, Harran University, Sanliurfa (Turkey)
[3]Department of Psychiatry, Faculty of Medicine, Harran University, Sanliurfa (Turkey)
[4]Department of Chest Surgery, Faculty of Medicine, Harran University, Sanliurfa (Turkey)

Abstract. – ***Background:*** **Oxidative stress is believed to have a role in the development of chronic diseases. It is also known that long-term night and shift work in nurses might be associated with many health-related problems like fatigue, sleep problems, anxiety and difficulties in maintaining regular lifestyles.**

Aim: **In this study, we aimed to evaluate the changes of oxidative stress parameters and anxiety indexes of the nurses on day and night shifts.**

Materials and Methods: **One hundred and twenty nurses in ordinary service and intensive care unit (ICU) were enrolled to the study. Subjects were divided into 2 groups; group 1 (n=60) consisted of nurses working in a day shift and group 2 (n=60) as working in the night shift. Further, both groups were divided in to 2 groups again; group 1a and 2a (both n=30) who working in the ICU, group 1b and 2b (both n=30) in the ordinary service. Just before and the end of the shifts, blood samples were obtained to measure total antioxidant status (TAS) and total oxidant status (TOS). Oxidative stress index (OSI) was calculated. Anxiety index were determined at the end of the shift using State-Trait Anxiety Inventory index.**

Results: **Oxidative stress parameters were increased in all nurses at the end of the day and night shifts ($p < 0.05$). However, both in service and ICU nurses TAS, TOS, and OSI levels were not significantly different at the beginning and the end of the shifts ($p > 0.05$). Anxiety indexes of each ordinary service and ICU nurses were found to be similar ($p > 0.05$).**

Conclusions: **Ordinary service and ICU nurses' oxidative stress parameters and anxiety indexes were not different and all nurses suffer the similar effects of the shifts both in day and night.**

Key Words:

Nurses, Workload, Oxidative stress, Anxiety.

Introduction

Number of the shift workers has rapidly increased worldwide over the last decades. Nurses work long hours under conditions of intense stress, is often suffer from excessive workloads and minimal social support. Long-term night and shift work in nurses becoming more cynical and less empathetic as their training progresses, and might be associated with many health-related problems like fatigue, sleep problems, anxiety and difficulties in maintaining regular lifestyles[1-4]. Reduced rest and recovery time leads to physiologic depletion or exhaustion that continues into the next workday. Consequently, shift workers have a higher prevalence of being unhealthy[5,6]. Numerous studies have shown high amounts of psychological distress in doctors, nurses, and other healthcare professionals working in various situations[7-9]. However, whether prolonged physical and extreme workload and mental stress induce relevant metabolic changes remains poorly understood[10-12].

Oxidative stress is believed to have a role in the development of chronic diseases. Once the balance between reactive oxygen species (ROS) production and antioxidative defense activity is disrupted, oxidative stress can occur, which may

Corresponding Author: Turgay Ulas, MD; e-mail: turgayulas@yahoo.com

result in cell injury or death, subsequent tissue damage, and, finally, chronic disease[13-15]. Increased oxidative stress associated with different jobs has been demonstrated by isolated studies. Also exhaustive and prolonged exercise has been shown to induce oxidative stress[16-20].

Although based on these knowledge mentioned above, no clinical research have been performed until now to evaluate the oxidative stress parameters with comparing the anxiety symptoms of the nurses. In this study we aimed, therefore, to evaluate anxiety symptoms using State Trait Anxiety Inventory (STAI) index and evaluate the changes of oxidative stress parameters of the nurses on day and night shifts. Moreover, we aimed to compare these levels between the ordinary service and intensive care unit (ICU) nurses.

Materials and Methods

Study Design

This prospective study was conducted at the Harran University School of Medicine, Sanliurfa, Turkey. Prior to subject recruitment, the study protocol was reviewed and approved by the local Ethics Committee, in accordance with the ethical principles for human investigations (ethical approval number; 28.01.2010: B.10.IEGO.0.11.00.01/021), as outlined by the Second Declaration of Helsinki and written informed consents were obtained from all the nurses. From January-2011 to September-2011 consecutively 120 nurses were recruited to the study.

All study subjects were divided into 2 groups; group 1 (n=60) consisted of nurses working in a normal day shift (08 am to 16 pm, 8 hours) and group 2 (n=60) as working in the night shift (16 pm to 08 am, 16 hours). Further, both groups were divided into 2 groups again; group 1a and 2a (both n=30) who working in the ICU, group 1b and 2b (both n=30) in the ordinary service. The exclusion criteria were as follows: recent acute infectious illness; any inflammatory, or infiltrative disorder; any evidence of liver, kidney, or respiratory disease; diabetes mellitus; malignancy; regular alcohol use; smokers; pregnancy; depression; psychiatric or neurological disorders. None of the patients had problems with adaptation to answer the questions of the STAI index. Just before the shift, blood samples were obtained to measure total antioxidant status (TAS) and total oxidant status (TOS). After the shift, blood samples were obtained again to measure TAS and TOS. STAI indexes were obtained from all subjects at the beginning and the end of the shifts.

Baseline Definitions and Measurements

Weight and height were measured according to standardized protocols. Body mass index was calculated as the weight in kilograms divided by the height in meters squared (kg/m^2). Blood pressure was measured by using a sphygmomanometer.

Biochemical Analysis

All blood samples were drawn from a large antecubital vein without interruption of venous flow, using a 19-gauge butterfly needle connected to a plastic syringe. Twenty milliliters of blood was drawn, with the first few milliliters discarded. The residual content of the syringe was transferred immediately to polypropylene tubes, which were then centrifuged at 3000 rpm for 10 minutes at 10 to 18^{o}C. Supernatant serum samples were stored in plastic tubes at -80^{o}C until assayed. For the serum markers of oxidant stress, TOS was measured and the oxidative stress index (OSI) calculated. TAS was measured as an indicator of antioxidant status.

Measurement of Total Oxidant Status

Serum TOS was measured using a novel automated method developed by Erel[21]. Oxidants present in the sample oxidize the ferrous ion-o-dianisidine complex to ferric ion. The oxidation reaction is enhanced by glycerol molecules, which are abundant in the reaction medium. The ferric ion generates a colored complex with Xylenol Orange in an acidic medium. Color intensity, which can be measured spectrophotometrically (V-530; Jasco®, Tokyo, Japan), is related to the quantity of oxidant molecules present in the sample. The assay is calibrated with hydrogen peroxide and the results expressed in terms of micro-molar hydrogen peroxide equivalents per liter (mol H_2O_2 equiv./l).

Measurement of Total Antioxidant Status

Serum TAS was measured using a novel automated method developed by Erel[22]. In this method, hydroxyl radical, the most potent biological radical, is produced. In the assay, ferrous ion solution in reagent 1 is mixed with hydrogen peroxide present in reagent 2. Sequentially-produced radicals, such as the brown-colored dianisidinyl radicalcation produced by the hydroxyl radical, are also potent radicals. This method allows measuring the antioxidative effect of the sample against potent free-radical reactions that are initiated by the hydroxyl radical. The assay has excellent precision values of more than 97%. The results are expressed as mmol Trolox equiv./l.

Oxidative Stress Index

The OSI was defined as the ratio of the TOS to TAS levels. For the calculation, TAC units were changed to mmol/l and the OSI value calculated according to the following formula[21,22]: OSI (arbitrary unit) = TOS (μmol H_2O_2 equiv./l)//TAS (mmol Trolox equiv./l).

Determination of the State Trait Anxiety Inventory (STAI) Index

The STAI was used to measure anxiety symptoms. The nurses were asked to complete a questionnaire concerning socio-demographic characteristics, the Turkish version of the Spielberger State-Trait Anxiety Inventory (STAI)[23]. The STAI is a self-report questionnaire consisting of two subscales, the state anxiety subscale and the trait anxiety subscale, each containing 20 items. Only the state anxiety subscale (STAI-S), which measures anxiety at the moment of scoring, was used in the analyses. Respondents use a four-point scale ranging from 1 to 4, the scores in this subscale range from 20 to 80 and higher scores indicate higher state anxiety. A sample response is 'I feel secure'.

Statistical Analysis

All statistical analyses were performed using SPSS for Windows version 17.0 (SPSS Inc., Chicago, IL, USA). After the shift and baseline differences of STAI-S indexes, TAS and TOS levels were calculated. Kolmogorov-Smirnov tests were used to test the normality of data distribution. The data were expressed as arithmetic means and standard deviations. Independent sample T-test was respectively used in normally and non-normally distributed continuous variables between groups. Paired t-test was used to analyze changes within each group. Pearson's correlation analysis was used to examine the association of oxidative stress parameters and STAI-S indexes in all groups. Two-sided p value < 0.05 was considered statistically significant.

Results

Group 1 Results

Clinical, biochemical and demographic characteristics of study subjects are presented on Table I. There were no statistical differences in biochemical and demographic characteristics

Table I. Comparison of demographic, laboratory and clinical characteristics of the day shift nurses.

	Group 1a (n = 30)	Group 1b (n = 30)	p^{α}
Gender, female	30	30	NS
Age, years	27.31 ± 4.37	29.03 ± 3.82	NS
BMI, kg/m^2	24.05 ± 4.33	23.42 ± 4.72	NS
Systolic BP, mmHg	110.34 ± 9.01	107.56 ± 7.89	NS
Diastolic BP, mmHg	71.23 ± 7.16	73.76 ± 8.65	NS
TAS at 8 am, μmol H_2O_2 equiv./l	1.00 ± 0.10	0.99 ± 0.12	NS
TOS at 8 am, mmol Trolox equiv./l	10.25 ± 2.13	9.62 ± 1.79	NS
OSI at 8 am, arbitrary unit	1.02 ± 0.21	0.98 ± 0.23	NS
TAS at 16 pm, μmol H_2O_2 equiv./l	0.94 ± 0.11	0.95 ± 0.14	NS
TOS at 16 pm, mmol Trolox equiv./l	11.35 ± 3.27	11.69 ± 3.96	NS
OSI at 16 pm, arbitrary unit	1.19 ± 0.36	1.23 ± 0.41	NS
Difference of TAS	-0.06 ± 0.15	-0.03 ± 0.13	NS
Difference of TOS	0.73 ± 6.60	1.86 ± 6.22	NS
STAI index score at 8 am	39.66 ± 5.67	39.33 ± 5.18	NS
STAI index score at 16 pm	38.93 ± 6.07	37.46 ± 4.63	NS
Difference of STAI index score	0.73 ± 6.60	1.86 ± 6.21	NS

All measurable values were given with mean ± standard deviation. NS: non significant; BP: blood pressure; BMI: body mass index; TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Invento-

Table II. Comparison of baseline and at the end of the day shift oxidative stress parameters.

	Group 1a (n = 30)			Group 1b (n = 30)		
	At 8 am	At 16 pm	p^{β}	At 8 am	At 16 pm	p^{β}
TAS, μmol H_2O_2 equiv./l	1.00 ± 0.10	0.94 ± 0.11	< 0.05	0.99 ± 0.12	0.95 ± 0.14	< 0.05
TOS, mmol Trolox equiv./l	10.25 ± 2.13	11.35 ± 3.27	< 0.05	9.62 ± 1.79	11.69 ± 3.96	< 0.05
OSI, arbitrary unit	1.02 ± 0.21	1.19 ± 0.36	< 0.05	0.98 ± 0.23	1.23 ± 0.41	< 0.05
STAI index score	39.66 ± 5.67	38.93 ± 6.07	> 0.05	39.33 ± 5.18	37.46 ± 4.63	> 0.05

All measurable values were given with mean ± standard deviation. TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Inventory. Paired sample T^{β} test was used.

among subgroups ($p > 0.05$ for all). Compared to group 1b, group 1a was not significantly different regarding to TAS, TOS, OSI levels at baseline and the end of the shift ($p > 0.05$ for all). In similar, STAI-S indexes, difference of TAS and TOS levels were not significantly different both in two subgroups ($p > 0.05$ for all). Besides, compared to baseline, at the end of the shift TAS levels were significantly decreased, TOS and OSI levels were significantly increased both in two subgroups ($p < 0.05$ for all) (Table I, II).

Group 2 Results

Clinical, biochemical and demographic characteristics of study subjects are presented on Table III. All of the findings in group 2 were found similar with respect to group 1 results (Table III, IV).

In bivariate analysis no correlations were found between oxidative stress parameters and STAI-S indexes in all groups ($p > 0.05$ for all).

Discussion

The main findings of this study were that: (1) oxidative stress parameters were increased in all service and ICU nurses at the end of the shifts; (2) however both in service and ICU nurses TAS, TOS, and OSI levels were not significantly different at the beginning and the end of the shifts; (3) besides, STAI-S indexes of each ordinary service and ICU nurses were found to be similar.

Measuring different oxidant and antioxidant molecules is impractical, and their oxidant and antioxidant effects are additive. Since there are nu-

Table III. Comparison of demographic, laboratory and clinical characteristics of the night shift nurses.

	Group 2a (n = 30)	Group 2b (n = 30)	p^{α}
Gender, female	30	30	NS
Age, years	28.54 ± 4.23	27.03 ± 3.81	NS
BMI, kg/m^2	23.92 ± 3.31	22.67 ± 3.52	NS
Systolic BP, mmHg	113.65 ± 11.98	117.25 ± 8.86	NS
Diastolic BP, mmHg	72.53 ± 8.63	74.05 ± 7.42	NS
TAS at 16 pm, μmol H_2O_2 equiv./l	1.03 ± 0.12	1.07 ± 0.22	NS
TOS at 16 pm, mmol Trolox equiv./l	10.99 ± 3.49	10.87 ± 2.57	NS
OSI at 16 pm, arbitrary unit	1.08 ± 0.37	1.05 ± 0.34	NS
TAS at 8 am, μmol H_2O_2 equiv./l	0.92 ± 0.14	0.90 ± 0.09	NS
TOS at 8 am, mmol Trolox equiv./l	12.67 ± 3.37	12.52 ± 4.64	NS
OSI at 8 am, arbitrary unit	1.34 ± 0.49	1.38 ± 0.46	NS
Difference of TAS	0.11 ± 0.15	0.16 ± 0.24	NS
Difference of TOS	-0.92 ± 4.13	-1.64 ± 5.49	NS
STAI index score at 16 pm	38.80 ± 5.30	40.63 ± 4.95	NS
STAI index score at 8 am	37.60 ± 5.59	37.03 ± 4.48	NS
Difference of STAI index score	1.20 ± 5.10	3.60 ± 4.61	NS

All measurable values were given with mean ± standard deviation. NS: non significant; BP: blood pressure; BMI: body mass index; TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Inventory. Independent sample T test$^{\alpha}$ was used.

Table IV. Comparison of baseline and at the end of the day shift oxidative stress parameters.

	Group 2a (n = 30)			Group 2b (n = 30)		
	At 16 pm	At 8 am	p^{β}	At 16 am	At 8 pm	p^{β}
TAS, μmol H_2O_2 equiv./l	1.03 ± 0.12	0.92 ± 0.14	< 0.05	1.07 ± 0.22	0.90 ± 0.09	< 0.05
TOS, mmol Trolox equiv./l	10.99 ± 3.49	12.67 ± 3.37	< 0.05	10.87 ± 2.57	12.52 ± 4.64	< 0.05
OSI, arbitrary unit	1.08 ± 0.37	1.34 ± 0.49	< 0.05	1.05 ± 0.34	1.38 ± 0.46	< 0.05
STAI index score	38.80 ± 5.30	37.60 ± 5.59	> 0.05	40.63 ± 4.95	37.03 ± 4.48	> 0.05

All measurable values were given with mean ± standard deviation. TOS: total oxidant status; TAS: total antioxidant status; OSI: oxidative stress index; STAI: State Trait Anxiety Inventory. Paired sample T^{β} test was used.

merous oxidants and antioxidants in the body, measuring total oxidant-antioxidant status is more valid and reliable[21,22]. When only a few parameters are measured, their levels may be unchanged or decreased, even when the actual oxidant status is increased, or viceversa. For these reasons, we used TOS and TAS levels in our study.

Several studies report stressful working conditions and/or poor work-related health outcomes among healthcare workers, generally nursing personnel. A large amount of Authors agree that there are multiple and important stressors at the clinics and hospitals where nursing personnel generally work[24-28]. Some studies have concluded that inadequate work planning and a poorly organized work schedule may impact health. In particular, this may result in a reduced quantity and quality of sleep, a decline in cognitive and physical performance and an associated increased risk for errors, and interference with family and social engagements[29-33]. Additionally, previous research studies on night shift working also pointed out the risk or associated factors in pathophysiology, lifestyle behaviour and job-related conditions and impaired circadian rhythm[34-36].

In literature, only one research study has been performed to evaluate oxidative stress parameters of the shift nurses, no research study has been performed to investigate the anxiety indexes of the nurses on their shifts. The only one study which Buyukhatipoglu et al[1] performed showed an increased oxidative stress in nurses working on their shifts. In our study, comparing to baseline, we found an increased oxidative stress at the end of the shift in all nurses. Presumably because of prolonged higher level physical activity, although other factors such as high period of shift time may have played a role for this. Beyond the previous published study, we compared ordinary service and ICU nurses' oxidative stress parameters and anxiety symptoms by using STAI-S index on their shifts, and found no difference among them. Namely, all ordinary service and ICU nurses suffer the similar effects of the shifts both in day and night shifts. As a result, we consider that the main reason for increased oxidative stress that we observed in nurses was prolonged, incessant, and low-grade to moderate-grade physical activity. Also, we hypothesized that increased workload without sufficient time to rest might disrupt oxidative and antioxidative balance, thereby causing oxidative stress in on-duty nurses. However, the mechanisms of these effects are poorly understood and contentious.

The results of this study raise concerns about the long-term influences of oxidative stress on the health of nurses, because oxidative stress has been implicated in the pathophysiology of a large number of diseases. Certain limitations of the present study should be considered. First of all, evaluation of continued 24 hour parameters which have been analyzed in the present study might represent the chronobiological characteristics of the nurses. The second was; sample size was relatively small. Therefore, these results should be verified with large-scale, multicenter prospective cohort studies.

References

1) Buyukhatipoglu H, Kirhan I, Vural M, Taskin A, Sezen Y, Dag OF, Turan MN, Aksoy N. Oxidative stress increased in healthcare workers working 24-hour on-call shifts. Am J Med Sci. 2010; 340: 462-467.
2) Akerstedt T, Kecklund G, Johansson SE. Shift work and mortality. Chronobiol Int 2004; 21: 1055-1061.
3) Knutsson A, Hammar N, Karlsson B. Shift workers' mortality scrutinized. Chronobiol Int 2004; 21: 1049-1053.
4) Sudo N, Ohtsuka R. Nutrient intake among female shift workers in a computer factory in Japan. Int J Food Sci Nutr 2001; 52: 367-378.

5) Rosa RR. Extended workshifts and excessive fatigue. J Sleep Res 1995; 4: 51-56.
6) Chee HL, Kandiah M, Khalid M, Shamsuddin K, Jamaluddin J, Nordin NA, Shuib R, Osman I. Body mass index and factors related to overweight among women workers in electronic factories in Peninsular Malaysia. Asia Pac J Clin Nutr. 2004; 13: 248-254.
7) Jex SM, Hughes P, Storr C, Baldwin DC Jr, Conard S, Sheehan DV. Behavioral consequences of job-related stress among resident physicians: the mediating role of psychological strain. Psychol Rep 1991; 69: 339-349.
8) Tholdy-Doncevis S, Romelsjo A, Theorell T. Comparison of stress, job satisfaction, perception of control and health among district nurses in Stockholm and pre-war Zagreb. Scand J Soc Med 1998; 26: 106-114.
9) Richardsen AM, Burke RJ. Occupational stress and work satisfaction among Canadian women physicians. Psychol Rep 1993; 72: 811-821.
10) Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. Ann Intern Med 2002; 136: 358-367.
11) Campbell DA Jr, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. Surgery 2001; 130: 696-702.
12) Davidson RJ, Kabat-Zinn J, Schumacher J, Rosenkranz M, Muller D, Santorelli SF, Urbanowski F, Harrington A, Bonus K, Sheridan JF. Alterations in brain and immune function produced by mindfulness meditation. Psychosom Med. 2003; 65: 564-570.
13) Cross CE, Halliwell B, Borish ET, Pryor WA, Ames BN, Saul RL, McCord JM, Harman D. Oxygen radicals and human disease. Ann Intern Med 1987; 107: 526-545.
14) Halliwell B, Gutteridge JM, Cross CE. Free radicals, antioxidants, and human disease: where are we now? J Lab Clin Med 1992; 119: 598-620.
15) Buyukhatipoglu H, Sezen Y, Yildiz A, Bas M, Kirhan I, Ulas T, Turan MN, Taskin A, Aksoy N. N-acetylcysteine fails to prevent renal dysfunction and oxidative stress after noniodine contrast media administration during percutaneous coronary interventions. Pol Arch Med Wewn. 2010; 120: 383-389.
16) Inoue A, Kawakami N, Ishizaki M, Tabata M, Tsuchiya M, Akiyama M, Kitazume A, Kuroda M, Shimazu A. Three job stress models/concepts and oxidative DNA damage in a sample of workers in Japan. J Psychosom Res 2009; 66: 329-334.
17) Ishihara I, Nakano M, Ikushima M, Hara Y, Yoshimine T, Haraga M, Nakatani J, Kawamoto R, Kasai H. Effect of work conditions and work environments on the formation of 8-OH-dG in nurses and non-nurse female workers. J UOEH 2008; 30: 293-308.
18) Bloomer RJ, Goldfarb AH, Wideman L, McKenzie MJ, Consitt LA. Effects of acute aerobic and anaerobic exercise on blood markers of oxidative stress. J Strength Cond Res 2005; 19: 276-285.
19) Fatouros IG, Jamurtas AZ, Villiotou V, Pouliopoulou S, Fotinakis P, Taxildaris K, Deliconstantinos G. Oxidative stress responses in older men during endurance training and detraining. Med Sci Sports Exerc 2004; 36: 2065-2072.
20) Tsuboi H, Tatsumi A, Yamamoto K, Kobayashi F, Shimoi K, Kinae N. Possible connections among job stress, depressive symptoms, lipid modulation and antioxidants. J Affect Disord 2006; 91: 63-70.
21) Erel O. A new automated colorimetric method for measuring total oxidant status. Clin Biochem 2005; 38: 1103-1111.
22) Erel O. A novel automated method to measure total antioxidant response against potent free radical reactions. Clin Biochem 2004; 37: 112-119.
23) Spielberger CD. State-Trait Anxiety Inventory: A Comprehensive Bibliography. Palo Alto, Calif, USA: Consultant Psychologists Press 1984.
24) Barnes-Farrell JL, Rumery SM, Swody CA. How do concepts of age relate to work and off-the-job stresses and strains? A field study of health care workers in five nations. Exp Aging Res. 2002; 28: 87-98.
25) Borges FN, Fischer FM. Twelve-hour night shifts of healthcare workers: a risk to the patients? Chronobiol Int. 2003; 20: 351-360.
26) Costa G, Bertoldi A, Kovacic M, Ghirlanda G, Minors DS, Waterhouse JM. Hormonal secretion of nurses engaged in fast-rotating shift systems. Int J Occup Environ Health. 1997; 3: 35-39.
27) Clissold G, Smith P, Acutt B. The impact of unwaged domestic work on the duration and timing of sleep of female nurses working full-time on rotating 3-shift rosters. J Hum Ergol (Tokyo) 2001; 30: 345-349.
28) Portela LF, Rotenberg L, Waissmann W. Self-reported health and sleep complaints among nursing personnel working under 12 h night and day shifts. Chronobiol Int 2004; 21: 859-870.
29) Dorrian J, Lamond N, van den Heuvel C, Pincombe J, Rogers AE, Dawson D. A pilot study of the safety implications of Australian nurses' sleep and work hours. Chronobiol Int 2006; 23: 1149-1163.
30) Trinkoff A, Geiger-Brown J, Brady B, Lipscomb J, Muntaner C. How long and how much are nurses now working? Am J Nurs 2006; 106: 60-71.
31) Akerstedt T. Shift work and disturbed sleep/wakefulness. Occup Med (Lond) 2003; 53: 89-94.
32) Fitzpatrick JM, While AE, Roberts JD. Shift work and its impact upon nurse performance: current knowledge and research issues. J Adv Nurs 1999; 29: 18-27.
33) Poissonnet CM, Véron M. Health effects of work schedules in healthcare professions. J Clin Nurs 2000; 9: 13-23.
34) Fischer FM, Borges FN, Rotenberg L, Latorre Mdo R, Soares NS, Rosa PL, Teixeira LR, Nagai R, Steluti J, Landsbergis P. Work ability of health care shift workers: What matters? Chronobiol Int 2006; 23: 1165-1179.
35) Park J, Ha M, Yi Y, Kim Y. Subjective fatigue and stress hormone levels in urine according to duration of shiftwork. J Occup Health. 2006; 48: 446-450.
36) Reeves SL, Newling-Ward E, Gissane C. The effect of shiftwork on food intake and eating habits. Nutr Food Sci 2004; 34: 216-221.