Egyptian Journal of Occupational Medicine, 2018; 42 (2) : 257-270

SERUM CORTISOL LEVEL AND DEPRESSION AMONG SHIFT-WORKING NURSING STAFF IN A UNIVERSITY HOSPITAL

By

Aldalatony MM[1,2], Elbadry AS[1], Al-Batanony MA[1,3] and Khader HF[3,4]

[1]Department of Community Medicine and Public Health, [4] Department of Biochemistry, Faculty of Medicine, Menoufiya ,Egypt, [2]Ministry of Health-Saudi Arabia, [3]Unaizah College of Medicine, Qassim University, Saudi Arabia.

Abstract

Introduction: Night shift is one of the most frequent reasons for disturbance of circadian rhythm, altering biological functions and can negatively affect physical, psychological well-being and work performance. **Aim of work:** To evaluate the associations between circadian rhythm differences in shift-working nurses by using serum cortisol level and depression. **Materials and Methods:** a cross-sectional study was conducted by means of anonymous self-administered questionnaire for one hundred ninety-two nurses working at Menoufiya University Hospital, Shebin Al-Kom City, Egypt. The study involved 96 nurses working night-shifts and 96 in day-shifts. To assess their depression levels, self-rated depression scale (SDS) was used. Serum cortisol level was measured at 8:00 am for all respondents. **Results:** The response rate was 97%. A significant increase in serum cortisol level was observed among night-shift respondents compared to day-shift ones. Among night-shift workers, older nurses with more years of employment and higher cortisol levels were significantly more prone to develop depression ($P<0.001$). **Conclusion:** Nurses working night-shifts need special attention due to the higher risk of depression and possibly other undesirable health effects. Systems for early identification of nurses with depression and for providing environments allowing nurses at work to take rest and relax in the early morning after night shift are necessary.

Keywords: Shift-work, Night-work, Serum cortisol level, Depression and Nurses.

Introduction

Human beings have an endogenous circadian clock (internal body clock with a 24-hour cycle) known as circadian rhythm, with a regular cycle of 23–25 hours, which is maintained even when affected by external stimuli (Otsuka, 1998 and Nakamura, 2012). The circadian rhythm is necessary for the regulation of such things as neural activities, immune functions, and sleep; importantly, it is connected with autonomic nervous system functions that include regulation of blood pressure, body temperature, metabolism; and endocrine secretions (Shinkai et al., 1993 , Otsuka, 1998 and Chiba, 2008). Nowadays, the number of individuals who is working night-shifts has increased. Synchronization of the biological rhythms for nurses, who are working in a system of alternating day and night shifts, is difficult (Grossman, 1997; Bunney and Bunney, 2000).

Cortisol is a hormone secreted by the adrenal gland. Cortisol level is measured as a physiological index of circadian rhythm and stress responses. Because it has various physiological influences on the immune, blood circulatory, and central nervous systems, cortisol is an important hormone to consider when determining physical and mental health. Cortisol is secreted during the period from the latter half of the sleeping phase to the time of waking up to promote gluconeogenesis during this period without energy supply to allow the body to be in an active state. It is believed that the usual sleep-wake rhythm is maintained even during night-shifts (Nakamura, 2012). Measuring blood cortisol levels from the day shift to the night shift in nurses showed that the levels peaked at 8:00 am, decreased in the evening; and further decreased at night; however, a rhythm was observed, with the levels elevated suddenly from 6:00 pm to 8:00 am next morning (Miyauchi et al., 2012). Recently, a syndrome called “shift-work disorder” has been identified by the presence of the following symptoms: alteration of circadian rhythm of sleep/wake, insomnia, excessive day sleepiness, and fatigue (Black et al., 2010 and Schwartz et al., 2010).

It is speculated that night-shift work, like jet lag, can frequently induce undesirable health effects (Ferri et al.,

2016). Previous studies reported that in addition to being easily tired, shift work causes anxiety, sleep disorder, fatigue and nervous temperament (Grossman, 1997 and Bunney and Bunney, 2000). Night-shift nurses who work against the circadian rhythm are susceptible to fatigue and decreased work performance, resulting in the occurrence of medical accidents and errors at night (Grossman, 1997 and Oriyama et al., 2011). Moreover, some studies have reported that night-shift nurses are prone to depression causing errors and medical incidents during work which happen particularly in the early morning (Gold et al., 1992 and Suzuki et al., 2004).

Despite all of these findings regarding working against circadian rhythm, the factors associated with depression tendency have not been objectively examined (Ferri et al., 2016).

Based on this background knowledge, this study examined differences in the circadian rhythm by measuring morning serum cortisol level among two-shift work nurses .This accumulated data would be helpful as a reference in order to regulate nursing practice in Egypt.

Materials and Methods

Study design: This was a cross-sectional study.

Date and duration of the study: The study was conducted during the period from January to the end of March 2016.

Study sample: A total of 192 non-smoking male and female nurses from Menoufiya University Hospital, Menoufiya governorate, Egypt, with ≥ 3 years of nursing work experience were enrolled in this study after exclusion of non-responders, and were divided into two groups:

- Group 1 (Study group): Included 96 participants who worked in the Emergency Room on a two-shift system during the 3 months preceding the study. The two-shift system consisted of about 12-hour night-shift (from 7:30 pm to 7:30 am the following day) 3 times/week and a 12-hour day-shift (from 7:30 am to 7:30 pm)
- Group 2 (Control group): Included 96 age and sex-matched controls

who worked morning shifts (from 7:30 am to 7:30 pm) in the in-patient departments during the 3 months preceding the study. Group 2 nurses were selected mostly from surgical departments like general surgery, orthopedics, obstetrics and gynecology and chest surgery so that there would be no significant difference between the two groups as regards work stress.

Nurses with ≥ 3 years of work experience were chosen based on a previous study which indicated that shift-work nurses adapted to the night-shift system in 3 years, during which body temperature increases were suppressed and metabolism was depressed. Thus, compared with the time when the nurses were new to the job, their subjective lack of sleep was improved.

The study purpose and method were explained to nurse participants. An interview was administered at the work place in a quiet room in the morning before starting the morning-shift or at the end of the night-shift. Five persons were examined every day and every setting took about 10-15 minutes. All participants were volunteers.

Study methods: All enrolled participants were subjected to:

I. Basic data questionnaire including age, sex as well as duration of employment. A pilot study, on 9 nurses, was done to test the simplicity of the questionnaire. Participants with current use of oral medications; suffering from any type of endocrine disorder or receiving hormonal treatment e.g. thyroxine, insulin, hormonal contraception as well as those receiving steroid therapy for any reason were excluded from the study.

II. Self-rating depression scale (SDS): The Zung Self-Rating Depression Scale is a 20-items self-report questionnaire that is widely used as a screening tool, covering affective, psychological and somatic symptoms associated with depression. The questionnaire takes about 10 minutes to complete, and items are framed in terms of positive and negative statements. It can be effectively used in a variety of settings, including primary care, psychiatric cases, drug trials and various research situations. Each item is scored on

a Likert scale ranging from 1 to 4 ("Rarely", "Sometimes", "Usually", and "Mostly"). The reliability and credibility of this scale have been examined and reported (Fukuda et al., 1983). A total score is derived by summing the individual item scores, and ranges from 20 to 80 and the levels of depression were assessed by the total score: 39 points or less indicate "little or no depression", 40–49 points indicate "mildly depressed", and 50 points or greater indicate "moderately depressed" (Fukuda et al., 1983). In the present study, a score of 39 or less indicated little or no depression; however, a score of 40 or more means having depression (either mild or moderate).

III. Brief general examination.

IV. Laboratory investigations:

A 5 ml blood sample was collected from each participant at 8 am at the end of the night-shift or at the beginning of the morning-shift. Serum was separated immediately, and stored refrigerated at (2-8°C) for 5 days. If storage time exceeded 5 days, serum was stored frozen at (-20°C) for as long as one month. Prior to assay, frozen sera were completely thawed and mixed well. Then they were examined by serum cortisol kits and read by Enzyme-Linked Immunosorbent Assay (ELISA) reader.

Normal values (Baig et al., 2006) Abcam's Cortisol (USA), in vitro competitive ELISA (Enzyme-Linked Immunosorbent Assay) kit is designed for the accurate quantitative measurement of Cortisol in serum and plasma with a cut off sensitivity at 2.44 ng/ml.

Classification (circadian rhythm)	ng/ml
8:00 AM-10:00 AM	50-230
4:00 PM	30-150

Consent

Written informed consents were signed by all participants before being enrolled into the study.

Ethical approval

Respective approvals of the review board and the ethics committee of the Menoufiya Faculty of Medicine were obtained before starting the study.

Data management

Quantitative data were expressed

as mean ± standard deviation (SD) and were compared between both groups using student t-test for parametric variables and Mann-Whitney test for non-parametric ones. On the other hand, qualitative data were presented as numbers and percentages (No and %) where chi-square test was used. Correlation coefficient test was used to compare non-dependable variables with dependable ones. p- value <0.05 was considered the level of significance.

Results

Table (1): Difference between study subjects and control regarding important variables.

Variables	Studied groups		p-value
	Subjects (No= 96)	Control (No=96)	
Age in years: (Mean±SD)	25.15±4.79	25.17±2.55	0.97
Sex:			
• Female	64 46.7	73 53.3	0.15
• Male	32 58.2	32 41.8	
Duration of employment (years)	6.23±4.39	5.55±1.53	0.48#
Cortisol level (ng/ml)	249.95±12.73	159.73±15.32	**<0.001****
SDS score	46.73±9.19	37.33±8.32	**<0.001****

All studied groups are non-smokers. #Mann-whiteny test.

**: Highly significant. SDS : Self-rating Depression Score

Table 1 showed that the mean serum cortisol level of nurses of the two-shift system (249.95±12.73 ng/ml), was higher than the normal value (50-230 ng/ml), and was significantly higher than that of morning-shift system group (159.73±15.32 ng/ml), which was still within the normal value. Moreover, nurses of the two-shift system had significantly higher scores of the Self-rating Depression Score (SDS) (46.73±9.19) than those of the morning shift system (37.33± 8.32).

Table (2): Relation between depression and some variables among the study group (the two-shift system).

Variables	Nurses		p-value
	Without depression (No= 58)	With depression (No=38)	
Age in years (Mean±SD)	23.14±3.49	28.21±4.92	**<0.001****
Sex:			
• Female	41 64.1	23 35.9	0.30
• Male	17 53.1	15 46.9	
Duration of employment (years)	4.59±3.12	8.74±4.88	**<0.001****
Cortisol level (ng/ml)	242.21±8.83	261.76±7.64	**<0.001****

**: Highly significant

Table 2 showed that among nurses of the two-shift system, older nurses (mean age of 28.21±4.92 years) and those with more years of employment (8.74±4.88 years) (38 nurses) were significantly more at risk of developing depression than those of younger age 23.14±3.49 and less years of employment (4.59±3.12 years) (58 nurses) (P<0.001). However, it is clear that those two-shift system nurses with depression had a significantly higher mean serum cortisol level (261.76±7.64 ng/ml) than those without depression (242.21±8.83 ng/ml) (p<0.001).

Table (3): Correlation between Self-rating Depression Score (SDS) score and cortisol level and years of employment among cases.

Variables	SDS score	
	R	p-value
Cortisol level (ng/dL)	0.89	**<0.001****
Years of employment	0.52	**<0.001****

**: Highly significant

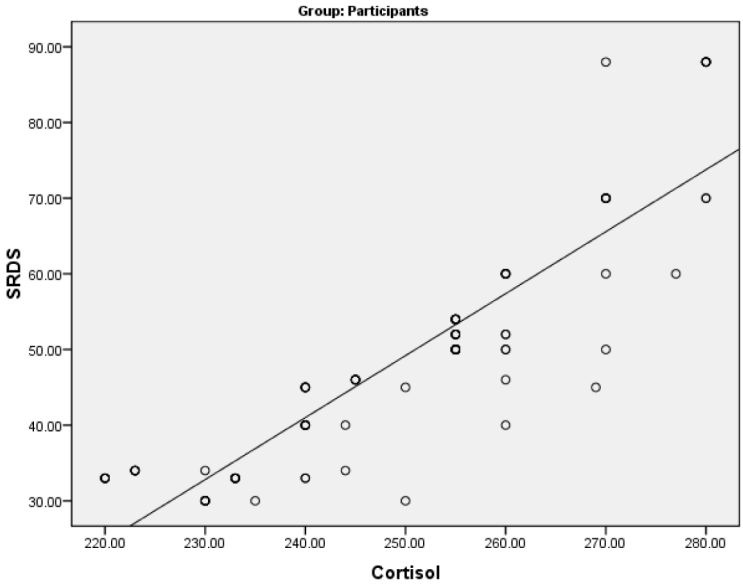

Figure (1): Pearson correlation between cortisol level and depression score.

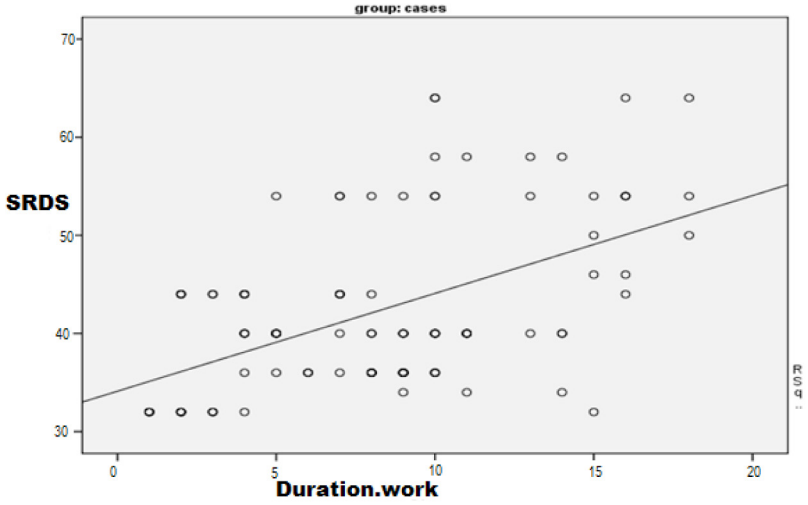

Figure (2): Pearson correlation between duration of employment in years and depression score.

Table 3, Figure 1 and 2 showed that the risk of developing depression was significantly higher (P<0.001) with increasing years of employment and with increasing serum cortisol level due to disturbed circadian rhythm.

Discussion

This study aimed to determine whether nurses working night-shifts experienced higher levels of serum cortisol and depression scores than their colleagues who worked day-shifts. In this study, the response rate was relatively high (97%) in comparison with other studies (Grossman, 1997 and Buja et al., 2013), indirectly suggesting the awareness of nurses of the potential impact of this issue on professional well-being.

The basic information provided, showed that all participants were experienced in nursing work as all were employed as nurses for three or more years. The subjects' average depression score by SDS was 46.73±9.19 for the study group compared to 37.33±8.32 for the control group (Table 1), the difference between both groups was statistically significant. This finding agrees with the results of Michie et al., 2015 who found that the average depression level among night-shift nurses was 43.4 SDS points. This finding also, agreed with Fukuda et al., 1983 who stated that the average SDS level among their study group of night-shift nurses was significantly higher than that among a control group of the general population. Previous SDS surveys of nurses found 40 or more points in 70% of the respondents, and nurses were generally considered to have lower mental well-being than the general population (Haratani, 1998 and Nakao, 2005).

Average morning serum cortisol level among our shift work nurses showed a significantly higher level (249.95 ± 12.73 ng/ml) in comparison with the control group (159.73 ± 15.32 ng/ml) (Table 1). To examine whether the circadian rhythm among the nurses differed depending on their depression level (based on the SDS level), we measure serum cortisol level at 8:00 am. We found that those with depression showed a significantly higher mean value of serum cortisol level (261.76±7.64 ng/ml) than those without depression (242.21±8.83 ng/

ml) (Table 2). This finding agreed with Michie et al., 2015 who reported a rapid increase in salivary cortisol level among nurses with depression in the morning following night-shifts indicating a phase deviation in the circadian rhythm that may have increased mental tension and stress earlier in this group than in the other group before work. They also suggested that night-shift nurses may be doing their duties in the early morning in spite of the presence of increased stress due to impaired circadian rhythm.

The result of this study was in concordance with Izawa et al., 2011 who reported that cortisol levels were increased by physical stress and acute mental stress, and that a literature review indicated that the levels were affected by chronic mental stress. Knorr et al., 2010 detected a relationship between circadian rhythm disorders and depression. Furthermore, Kato et al., 2006 and Izawa et al., 2007 found that cortisol level increased before work because of tension and stress. Moreover, Saleh et al., 2014 concluded that shift workers often experience circadian disturbance, especially when they are working overnight or in rotating shifts. In a random-effects meta-analysis done by Knorr et al., 2010 over twenty case control studies, including 1354 participants with depression and 1052 control persons, it was observed that average salivary cortisol was higher in depressed individuals as compared to control persons in the morning (p-value 0.002) and in the evening (p-value 0.03).

Burch et al., 2005 and Gu et al., 2015 agreed in indicating that night-shift work imposes circadian strain and leads to a greater number of physical and psychological symptoms with a higher risk for several chronic diseases than other shift schedules. This is also in line with other studies (Øyane et al., 2013 and Waage et al., 2014), which suggested that night-shift work represents a stress factor, which can lead to chronic discomfort and mild somatic alterations, predisposing to the development of psychological diseases. In fact, Costa, 2012 and Niu et al., 2015 indicated that different clockwise rotations (morning/afternoon/ night) as well as the no rapid sequential rotation could be more protective, as nurses require at least 4 days to adjust their

circadian rhythms of cortisol secretions after a night shift.

In this study, older nurses (mean age was 28.21±4.92) with more years of employment (mean years was 8.74±4.88) were more prone to having depression (Table 2). This observation agreed with a statement of the Royal College of Nursing , 2012 that older workers who have worked shifts for a number of years may be more vulnerable to health risks than others.

Most studies highlighted a significant positive association between quick returns (<11 hours off work between two work shifts) and insomnia, sleepiness, fatigue, depression and other shift work disorders (Eldevik et al., 2013 and Flo et al., 2014). A regulation of at least 11 hours off work between two work shifts, as applied in many European countries, could ensure more shift worker well-being.

Conclusion and Recommendations

In the present study, in the morning, after a night-shift, an increase in the serum cortisol level was observed among nurses diagnosed with depression according to SDS score, indicating an impaired circadian rhythm that may have increased mental tension and stress during work.

Future research should assess the implementation of serum cortisol level and depression score examination of nurses prior to their working in stressful conditions as in the Emergency Department and at night-shifts and to better analyze the burden of shift work on the health and well-being of workers and patients. Our results suggest that workers on night-shift schedule need special attention and frequent health checks due to the higher risk for both job dissatisfaction and undesirable health effects. Regulations of more hours of rest between two work shifts aims at reducing the adverse effects of shift schedules and can permit a better organization of health care.

Limitations of the study: This study was conducted at one medical setting with lack of a comparison with other hospitals. Additionally, it had a small sample size. Moreover, causal relationship between the work-shift modality and the selected variables cannot be completely evaluated by its cross-sectional design. To

investigate this topic in greater depth, further prospective research on larger samples collected in many health care environments could help to conclude whether the study results can be representative and characteristic of shift-working nurses and to confirm the findings of this study.

Furthermore, measuring serum cortisol level once for each participant at 8 am (at the end of the night-shift or at the beginning of the morning-shift) not at several occasions, because of its high cost is a limitation also.

References

1. Baig A, Siddiqui I, Naqvi H, Sabir S, Jabbar J et al., (2006): Correlation of serum cortisol levels and stress among medical doctors working in emergency departments. J Coll Physicians Surg Pak; 16 (9): 576-80.
2. Black JE, Hull SG, Tiller J, Yang R and Harsh JR (2010): The long-term tolerability and efficacy of armodafinil in patients with excessive sleepiness associated with treated obstructive sleep apnea, shift work disorder, or narcolepsy: an open-label extension study. J Clin Sleep Med; 6 (5): 458–66.
3. Buja A, Zampieron A, Mastrangelo G, Petean M, Vinelli A, et al., (2013): Strain and health implications of nurses' shift work. Int J Occup Med Environ Health; 26 (4): 511–21.
4. Bunney WE and Bunney BG (2000): Molecular clock genes in man and lower animals: possible implications for circadian abnormalities in depression. Neuro-psycho-pharmacology; 22: 335–45.
5. Burch JB, Yost MG, Johnson W and Allen E (2005): Melatonin, sleep, and shift work adaptation. J Occup Environ Med; 47(9): 893–901.
6. Chiba S (2008): Shift workers and sleep disorders. J Transport Med; 62: 132–40.
7. Costa G (2012): Summary preventive and corrective measures for shift workers. G Ital Med Lav Ergon; 34 (3): S326–S328.
8. Eldevik MF, Flo E, Moen BE, Pallesen S and Bjorvatn B (2013): Insomnia, excessive sleepiness, excessive fatigue, anxiety, depression and shift work disorder in nurses having less than 11 hour in-between shifts. PLoS One; 8 (8): e70882.
9. Ferri P, Guadi M, Marcheselli L, Balduzzi S, Magnani D et al., (2016): The impacts of shift work on the psychological and physiological health of nurses in a general hospital: a comparison between rotating night-shifts and day-shifts. Risk management and health policy; 9: 203-11.
10. Flo E, Pallesen S, Moen BE, Waage S and Bjorvatn B (2014): Short rest periods between work shifts predict sleep and health problems in nurses at 1-year follow-up. Occup Environ Med; 71(8): 555–61.
11. Fukuda K and Kobayashi S (1983): Japanese version SDS (Self-Rating Depression Scale): Manual. Sankyobo.
12. Gold DR, Rogacz S, Bock N, Tosteson TD, Baum TM et al., (1992): Rotating shift word, sleep, and accidents related to sleepiness in hospital nurses. Am J Public Health; 82: 1011–4.
13. Grossman VG (1997): Defying circadian rhythm: the emergency nurse and the night shift. J Emer Nurs; 23: 602–7.
14. Gu F, Han J, Laden F, Pan A, Caporaso NE et al., (2015): Total and cause-specific mortality of U.S. nurses working rotating night shifts. Am J Prev Med; 48(3): 241–52.
15. Haratani T (1998): Nurses'stress. Stress in nurses. Jap J Stress Sci; 12: 160–4.

16. Izawa S, Matsuura K and Haratani T (2011): Psychosocial stress in the work environment and measurement of cortisol: A systematic review. Job Stress Res; 18: 161–72.
17. Izawa S, Shirotsuki K, Sugaya N, Ogawa N, Suzuki K et al., (2007): The application of saliva to an assessment of stress: procedures for collecting and analyzing saliva and characteristics of salivary substances. Jpn J Compl Alternative Med; 4: 91–101.
18. Kato M, Ito Y, Naga S and Shimizu J (2006): Effects of moderate exercise on chronic stress: an analysis from salivary cortisol concentration and subjective mood data. J Anal Bio Sci; 29: 146–50.
19. Knorr U, Vinberg M, Kessing LV and Wetterslev J (2010): Salivary cortisol in depressed patients versus control persons: a systematic review and meta-analysis. Psychoneuroendocrinology; 35: 1275–86.
20. Korompeli A, Muurlink O, Tzavara C, Velonakis E and Lemonidou C (2014): Influence of shift work on Greek nursing personnel. Saf Health Work; 5 (2):73–9.
21. Michie B, Mitsuru O, Kayoko K, Kyoko N, Lourdes R et al., (2015): Analysis of salivary cortisol levels to determine the association between depression level and differences in circadian rhythms of shift-working nurse. J Occup Health; 57: 237-44.
22. Miyauchi F, Kimura K, Hirano M, et al., (2012): Effects of working at night on plasma cortisol concentrations and BMI in female nurses. JJOMT; 60: 348–52.
23. Nakamura W (2012): Circadian regulation of sleep-wake cycles and food anticipation. Brain Nerve; 64: 647–56.
24. Nakao H (2005): Influence of marital status on female nurses' depression. Yamaguchi Med J; 54: 165–73.
25. Niu SF, Chung MH, Chu H, Tsai JC, Lin CC et al., (2015): Differences in cortisol profiles and circadian adjustment time between nurses working night shifts and regular day shifts: A prospective longitudinal study. Int J Nurs Stud; 52 (7): 1193–201.
26. Oriyama S, Miyakoshi Y and Kobayashi T (2011): Influence of night-shift work on nurses: changes in activity, sleepiness, fatigue and physiological indices during night shifts. J Jap Soc Healthcare Admin; 147: 23–32.
27. Otsuka K (1998): Chronome and Janus-medicine. Heart rate variability (HRV) and BP variability (BPV) from a viewpoint of chronobiology and ecology. Tokyo: Med. Rev; Pp: 213.
28. Øyane NM1, Pallesen S, Moen BE, Akerstedt T and Bjorvatn B (2013): Associations between night work and anxiety, depression, insomnia, sleepiness and fatigue in a sample of Norwegian nurses. PLoS One; 8 (8): e70228.
29. Royal College of Nursing (2012): A shift in the right direction. RCN short guidance on the occupational health and safety of shift working nurses and health care assistants. WWW.rcn.org.uk/direct
30. Saleh AM, Awadalla NJ, El-masri YM and Sleem WF (2014): Impacts of nurses' circadian rhythm sleep disorders, fatigue, and depression on medication administration errors. Egypt J of Chest Dis and Tuberc; 63 (1): 145–53.
31. Schwartz JR, Khan A, McCall WV, Weintraub J and Tiller J (2010): Tolerability and efficacy of armodafinil in naïve patients with excessive sleepiness associated with obstructive sleep apnea, shift work disorder, or narcolepsy: a 12-month, open-label, flexible-dose study with an extension period. J Clin Sleep Med; 6 (5): 450–57.
32. Shinkai S, Watanabe S, Kurokawa Y and Torii J (1993): Salivary cortisol for monitoring circadian rhythm variation in adrenal activity during shiftwork. Int Arch Occup Environ Health; 64: 499–502.
33. Suzuki K, Ochida T, Kaneita Y, Yokoyama E, Miyake T et al., (2004): Mental health status, shift work, and occupational accidents among hospital nurses. J Occup Health; 46: 448–54.
34. Waage S, Pallesen S, Moen BE, Magerøy N, Flo E et al., (2014): Predictors of shift work disorder among nurses: a longitudinal study. Sleep Med; 15(12):1449.