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The effects of light intensity on day and night shift nurses' health performance

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ABSTRACT

This study shed the light on the effect of light intensity on some of the dependent variables, such as blood oxygen saturation (SPO_2%), heart pulse rate (P.R), arterial blood pressure (systolic (SBP), diastolic (DBP)), and tympanic temperature (T) of nurses, in their shift work.The sample consists of 207 nurses of both genders (104 female, 103 male), with mean age 29 years, and the mean duration of employment 6 years, were randomly chosen as a sample to fulfill the aim meant. This sample was taken from four hospitals in Nablus city. The values of light intensity in all hospital ranged from 220 Lux to 1000 Lux, at the day shift, and from 500 Lux to 1700 Lux, at the night shift. A number of measurements concerning the blood oxygen saturation, heart pulse rate, arterial blood pressure (systolic and diastolic), and tympanic temperature at different light intensities were taken for the selected sample before and an after exposure to light. Strong positive correlation (Pearson Correlation Coefficient) with light intensity was found for all measured variables. The statistical result for the dependent variables (SPO_2%, P.R, SBP, DBP, T) showed that Pearson correlation coefficient (R) between light intensity and the dependent variables are approximately equal to one, and the Probabilities (P) are < 0.05.

INTRODUCTION

The intensity of radiation is a measure of the energyflux, or it can be defined as the total energy per unit area per unit time[1].

Light can disrupt the body's production of melatonin, which is a hormone produced by pineal gland in brain, melatonin helps in regulating other hormones and maintains the body's circadian rhythm[2].

Human body needs light, in limited quantities.The suitable amounts depend on several factors including the type of activity or work performed by human, the gender and the work environment.

The Occupational Safety and Health Administration (OSHA) sat the occupational light standards[3], suitable for human health such as the recommended illumination intensities in lux in different work spaces, as shown in TABLE 1.

Health is defined by the World Health Organization (WHO) as a state of complete physical, mental and social well-being and not merely the absence of disease and infirmity[4]. Health performance is represented by blood oxygen saturation, blood pressure, heart pulse rate and tympanic temperature.

The value of these factors are as follows; (98 - 100%) for blood oxygen saturation, (70) mmHg for diastolic blood pressure and (120) mmHg for systolic blood pressure, (70) beats/min for heart pulse rate and (37°C) for tympanic temperature[5].

Previous studies

Some studies support the relationship between light-

TABLE 1 : Recommended illumination intensities in lux in different work spaces

Illumination Lux	Activity
20 – 50	Public areas with dark surroundings
50 – 100	Simple orientation for short visits
100 – 150	Working areas where visual tasks are only occasionally performed
150	Warehouses, Homes, Theaters, Archives
250	Easy Office Work, Classes
500	Normal Office Work, PC Work, Study Library, Groceries, Show Rooms, Laboratories
750	Supermarkets, Mechanical Workshops, Office Landscapes
1,000	Normal Drawing Work, Detailed Mechanical Workshops, Operation Theatres
1500 – 2000	Detailed Drawing Work, Very Detailed Mechanical Works
2000 – 5000	Performance of visual tasks of low contrast and very small size for prolonged periods of time

ing and human performance, body temperature, human circadian pacemaker, blood oxygen saturation and hormone melatonin.

Hussein[6] in his study showed that shift work, in particular night work can have negative effects on the health, safety, and well-being of workers. His study clearly showed that bright light administration could not reduce anxiety symptoms, somatic symptoms, severe depression and improved social dysfunction significantly during night shift[6]. However, bright light exposure significantly decreased the perception stress and burnout syndrome during night permanent shift. These results suggest that bright light might have provoked changes in perception stress and burnout syndrome of nurses working night permanent shift

When body is exposed to low intensity light, during night, a hormone called melatonin is produced by pineal gland in the brain[7]. It has been shown that the hormone reduces both blood pressure and body temperature. Therefore, it has been explored as a treatment option for insomnia, hypertension and cancer

People are routinely exposed to electrical lighting in the evening hours during work and social activities. A study carried out by Joshua[8] of Brigham and Women's Hospital shows that exposure to indoor light has a strong suppressive effect on the hormone melatonin. This could have effects on sleep quality and the body's ability to regulate body temperature, blood and glucose level.

A study conducted to explore the effect of night shift on Jordanian nurses at critical care units, using a structured questionnaire describes the effect of night shift among nurses working in critical care units[9]. The results showed that female nurses had a significant difference on sufficient sleep, and interpersonal conflicts[9]. In addition, the results indicated that nurses experience health problems and their work performance were affected by the night shift. The study also indicated that night shift affects critical care nurses well-being

In young – Mental Hospital, a research showed that real night shift workers can improve nocturnal alertness and daytime sleep when they are exposed to bright light in their work place. These improvements can be maximized by attenuating morning light on the way home[10].

Another study showed that melatonin levels dropped by 71%, 67%, 44%, 38% and 16% exposing to one hour of light at mid night using different level of light intensities: 3000, 1000, 500, 350 and 200 lux respectively[11]

A study was performed in China on the effect of light on the physiological parameters of the premature relationship with premature infants' physiological parameters and the heart pulse rate respiration showed that pulse rate increased and the blood oxygen saturation decreased as the intensity of light went up[12]

Objectives

In this study, light intensity in four different hospitals in Nablus city was measured. These are Arab Specialist Hospital, Union Hospital, Rafidia Government Hospital, and Nablus Specialist Hospital. The light intensity was compared to the recommended values. The effect

of light intensity on blood oxygen saturation, systolic and diastolic blood pressure, pulse rate and tympanic temperature, were studied.

Background

Oxygen saturation is defined as the ratio of oxhemoglobin to the total concentration of hemoglobin in blood.A hemoglobin molecule can carry a maximum of four oxygen molecules[13]. The level can be measured with the help of a pulse oximeter attached to a finger. A 95-100% level is considered as normal or healthy while 80-94% oxygen is considered as low blood oxygen or hypoxemia. In children, 97%oxygen level (at least 97% of the blood stream should be oxygen saturated) is considered as normal. Very low level of oxygen (less than 80%) can lead to serious symptoms. As blood that contains oxygen is circulated to the cell and tissues, a healthy level of oxygen in arteries can keep the organs functioning. Hyperoxia is a condition caused by very high level of oxygen in blood. Breathing high concentration of oxygen can lead to hyperoxia which is an equally serious condition. It causes cell death and serious damage, especially to the central nervous system, eye and lungs[14].

Blood pressure is defined as the force of the blood pushing against the walls of the arteries. Each time the heart beats, it pumps blood into the arteries. During each heartbeats, blood varies from a maximum (systolic) and a minimum (diastolic) pressure[15].

Blood pressure is measured by the systolic and diastolic values.The systolic pressure represents the pressure in the arteries as the heart contracts and pumps blood, while the diastolic pressure, represents the pressure in the arteries as the heart relaxes. Normal blood pressure is considered to be 120/70 mmHg[16]. the value, 120 mmHg is being the systolic pressure while 70 mmHg is being the diastolic pressure. Blood pressure varies during the day. It is lowest when one is sleeping and arises when one is excited, nervous or active. High blood pressure or hypertension means high pressure in arteries.

Blood pressure of 140/90 mmHg or above is considered as high blood pressure. In high blood pressure, the heart works harder, and the chances of a stroke or heart attack are greater[17].

Heart Pulse rate is the number of times the heart beats in one minute (beat/min). Pulse rates vary from person to person; pulse rate decreases when somebody is at rest and increases while exercising, because the body needs more oxygen-rich blood.

One common place to check body temperature is in the ear. This is called the "tympanic temperature" as the formal name for the eardrum is the "tympanic membrane". It only takes several seconds to check tympanic temperature. This method has become so common because it is much faster and accurate than obtaining a rectal or oral temperature[18].

Methodology

The population sample consists of nurses from four different hospitals in Nablus city. These are Arab Specialist Hospital, Union Hospital, Rafidia Government Hospital, and Nablus Specialist Hospital.

This study was applied to 207 nurses, 103 males and 104 females. They were 21 – 50years old. The nurses chosen had no cardiovascular disease, or hearing impairment. The selected nurses had at least a one year work. Moreover the nurses were asked not to smoke or to eat salty food before taking the measurement, to minimize factors which affect blood pressure and other parameters.The examined nurses, female or male, have no health problems according to their hospital records.

The best value of the sample is calculated according to Cochran formula[19]:

$$n = \frac{Z^2\, p\, q}{\delta^2} \qquad (1)$$

Where, n = best value to select a random sample of nurses in each hospital, Z = 1.96(p)(q) = estimate of variance, q = 1 - p, p = 0.9, q = 0.1, and δ= acceptable margin of error for proportion being estimated to be 0.055.

Using eq. (1) we get n = 114.3 andapplying the correction formula of Cochran:

$$m = \frac{n}{1+\frac{n}{N}}\ , \qquad (2)$$

where m = correlation sample size that should be used, and N = the actual sample number of nurses that found in each hospital[19].

Using Eq. (2), the number of nurses that should be examined (m) in different hospitals is as follows:

- (71) in Rafidia Government Hospital (H_1).
- (49) in Nablus Specialist Hospital (H_2).
- (53) in Arab Specialist Hospital (H_3).
- (34) in Union Hospital (H_4).

The measurements were done twice; the first was half an hour before the nurses' start their shift, the second measurement was seven hours after they have done their shift.

The nurses were asked to be at rest for half an hour before they started their shift.

Light Intensity and Sound Pressure Level were taken every minute during measurement, starting from (2.00 p.m) till (9.00 p.m) and from (9.00 p.m) till (4.00 a.m).

The measurements were taken during a period of one week for each hospital and on the average 5 times for each nurse. The light intensity was measured in the nurse room at reassigned value of 100 lux before the shift starts. The light intensity was measured in various positions in each hospital and averaged to get the value of light intensity during the shift

The values of light intensity in all hospital ranged from 220 Lux to 1000 Lux, at day shift, and from 500 Lux to 1700 Lux, at night shift.

Previous studies show that there is a considerable impact of noise on the blood pressure and other parameters[20-24]. Therefore, nurses working in areas of noise level (L_p>50 dB) were not included in the sample to make sure that the effect of noise on the measured parameters is excluded..

The sample was taken by convenient sampling technique which means that we talk only the available nurses.

Experimental apparatus

- Lux Meter
- Automatic Blood Pressure Monitormicro life AG, Modno. BP 2BHO
- Pulse Oximeter LM-800
- The GT-302/GT-302-1 Ear Thermometer
- Sound Pressure Level Meter

Statistical analysis

The gathered data were digitalized in a database developed with SPSS and Microsoft excel program. The measurements were analyzed statistically as the following:

- Pearson correlation factor (R) and the probability (P) will be used to measure the strength correlation between light intensity levels the dependent variable, and the dependent variables before and after exposure to light. Values with $P < 0.05$ were considered statistically significant.

Measurements and results

The results of measurement of light intensity and sound pressure level for all hospital before and after are shown in (TABLE 2).

TABLE 2 : Sound pressure level and light intensity for all hospital before and after the nurses start and finish their work

Hospitals	Average value of SPL (dB(A)) For two shifts	LI (before) For two shifts (Lux)	Average value of LI at day shift (after) (Lux)	Average value of LI at night shift (after)(Lux)
H_1	50	100	1000	1700
H_2	50	100	700	900
H_3	50	100	500	800
H_4	50	100	220	500

Where H_1isRafidia Government Hospital, H_2 Nablus Specialist Hospital, H_3 is Arab Specialist Hospital, H_4 is Union Hospital.

Measurements of health effects of light intensity

Results of measurements for blood oxygen saturation, pulse rate, blood pressure (systolic and diastolic pressure), and tympanic temperature at different levels of light intensities in different hospitals are shown in TABLES 3-8.

It is found that there is a strong positive correlation (Pearson correlation coefficient) between light intensity, as independent variable and blood oxygen saturation, pulse rate, blood pressure (systolic and diastolic pressure), and tympanic temperature at different intensities of light as dependent variables (TABLE 9).

Results of measurements for blood oxygen saturation and blood pressure (systolic) in day shift at different levels of light intensities in different hospitals before and after the shift are plotted in Figures 1 and 2.

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TABLE 3 : Min, Max, mean, and S.D values of studied variables for selected nurses in Rafidia governmental hospital (H_1)at day shift (2 p.m – 9 p.m)

Rafedia Governmental Hospital (H_1) At average LI (1000 Lux)				
Variables	**Min**	**Max**	**Mean**	**S.D**
Age (years)	22	55	33	8
Duration of employment (years)	1	25	8	6
SPO_2% (b)	94	100	98	1
SPO_2% (a)	91	97	95	1
SBP mmHg (b)	90	151	124	12
SBP mmHg (a)	115	151	136	9
DBP mmHg (b)	50	95	78	10
DBP mmHg (a)	70	100	86	8
T (^oC) (b)	36.1	37.1	36.7	0.3
T (^oC) (a)	36.7	37.6	37.1	0.2
HPR beats /min (b)	56	110	81	10
HPR beats / min (a)	68	120	90	9

TABLE 4 : Min, Max, Mean, and S.D. values of studied variables for selected nurses in Rafidiagovernmental hospital (H_1) at night shift (9 p.m – 4 a.m)

Rafedia Governmental Hospital (H_1) At average LI (1700 Lux)				
Variables	**Min**	**Max**	**Mean**	**S.D**
Age (years)	21	58	31	9
Duration of employment (years)	1	25	7	7
SPO_2% (b)	93	100	97	2
SPO_2% (a)	92	98	94	1
SBP mmHg (b)	90	150	127	13
SBP mmHg (a)	105	151	139	10
DBP mmHg (b)	52	93	81	10
DBP mmHg (a)	63	96	89	9
T (^oC) (b)	36.0	37.6	36.8	0.4
T (^oC) (a)	36.2	37.6	37.4	0.3
HPR beats /min (b)	63	112	83	12
HPR beats / min (a)	67	120	93	13

TABLE 5 : Min, Max, Mean, and S.D. values of studied variables for selected nurses in Union Hospital(H_4) at day shift (2 p.m– 9 p.m)

Union Hospital (H_4) At average LI (220 Lux)				
Variables	**Min**	**Max**	**Mean**	**S.D**
Age (years)	21	50	31	8
Duration of employment (years)	1	25	7	6
SPO_2% (b)	95	100	98	1
SPO_2% (a)	93	98	96	1
SBP mmHg (b)	110	141	116	10
SBP mmHg (a)	112	145	122	9
DBP mmHg (b)	55	89	72	8
DBP mmHg (a)	66	93	78	7
T (^oC) (b)	35.5	37.1	36.2	0.4
T (^oC) (a)	36.0	37.2	36.3	0.3
HPR beats /min (b)	59	104	75	12
HPR beats / min (a)	65	110	80	13

TABLE 6 : Min, Max, Mean, and S.D. values of studied variables for selected nurses in Union hospital (H_4) at night shift (9 p.m – 4 a.m)

Union Hospital (H_4) At average LI (500 Lux)				
Variables	**Min**	**Max**	**Mean**	**S.D**
Age (years)	21	50	31	8
Duration of employment (years)	1	25	7	6
SPO_2% (b)	93	100	97	2
SPO_2% (a)	91	98	95	1
SBP mmHg (b)	110	145	119	10
SBP mmHg (a)	112	150	126	9
DBP mmHg (b)	65	90	75	7
DBP mmHg (a)	70	95	82	7
T (^oC) (b)	35.5	37.2	36.5	0.4
T (^oC) (a)	36.0	37.3	36.7	0.3
HPR beats /min (b)	59	110	77	14
HPR beats / min (a)	65	112	84	14

TABLE 7 : Net change of blood oxygen saturation, pulse rate, and blood pressure (systolic and diastolic) before and after exposure to light intensity for all nurses at day shift (2 p.m – 9 p.m)

Differences between means	H_1	H_2	H_3	H_4
SPO_2%	2.95	2.30	2.21	1.64
S.B.P mmHg	11.62	9.49	7.62	6.02
D.B.P mmHg	7.92	6.64	6.10	5.96
T(^0C)	0.43	0.40	0.33	0.10
H.P.R beats/min	9.16	6.63	6.00	5.16

TABLE 8 : Net change of blood oxygen saturation, pulse rate, and blood pressure (systolic and diastolic) before and after exposure to light intensity for all nurses at night shift (9 p.m – 4 a.m)

Differences between means	H_1	H_2	H_3	H_4
SPO_2%	3.00	2.42	2.30	1.81
S.B.P mmHg	12.07	10.66	8.11	7.32
D.B.P mmHg	8.01	7.77	7.60	6.85
T(^0C)	0.50	0.42	0.36	0.21
H.P.R beats/min	9.90	7.88	7.00	6.85

TABLE 9 : Paired sample correlation of all studied variables before (b) and after (a) exposure to light intensities for all selected nurses in all hospitals

paired variables	Correlation Pearson	Sig-P- value
LI (Lux) and SPO_2 % (b)	0.957	0.043
LI (Lux) and SPO_2 % (a)	0.980	0.020
LI (Lux) and SBP mmHg (a)	0.989	0.011
LI (Lux) and SBP mmHg (b)	0.927	0.073
LI (Lux) and DBP mmHg (b)	0.981	0.019
LI (Lux) and DBP mmHg (a)	0.985	0.015
LI (Lux) and T (^{o}C) (b)	0.895	0.004
LI (Lux) and T (^{o}C) (a)	0.990	0.010
LI (Lux) and HPR beats/min (b)	0.966	0.034
LI (Lux) and HPR beats/min (a)	0.988	0.012

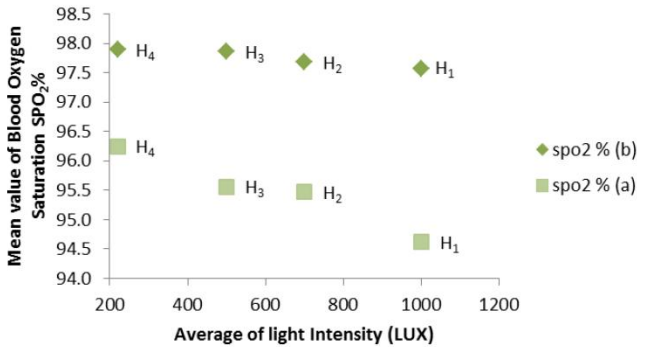

Figure 1 : Mean values of blood oxygen saturation (SPO_2%) of nurses as a function of light intensity in day shift

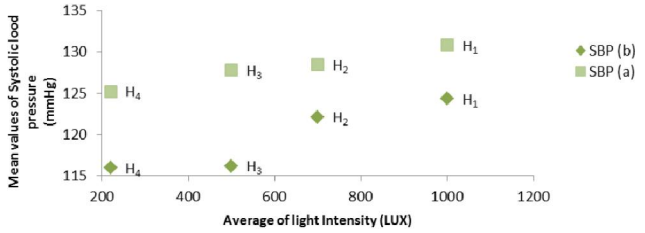

Figure 2 : Mean values of systolic blood pressure (SBP) of nurses as a function of light intensity in day shift

DISCUSSION

Effects of the light intensity on all parameters in night shift were more than in day shift as shown in TABLES 3-8. The results of this study are in agreement with other studies which support that exposure to light intensity leads to increase blood pressure Pandi et *al*[25].

The behavior of heart pulse rate as a dependent variable showed a continuous increase with the increase of light intensity at day shift, and at night shift. This is in good agreement with the study conducted by Peng et *al*[12].

There is a decrease in blood oxygen saturation with the increase of light intensity. That was the case in all hospitals, for all nurses and employment periods. It was clear that the increment in blood oxygen saturation is more for older nurses than for younger nurses and also those newly employed nurses were less affected by light intensity than their mates of higher employment periods. The measurements for temperature showed that there is an increase in temperature with an increase of light intensity. That was the case in all hospitals, for all nurses and employment periods. The increment in temperature is more for older nurses than for younger nurses. Those newly employed nurses are less affected by light intensity than their mates of higher employment periods. This agrees with the study conducted byZamanian*et al*[26]. The effect of light intensity on female is found to be more than on male.

REFERENCES

[1] J.Peter; Fundamentals college physics Wm.C.Brown Publishers, Edition, 738 **(1995)**.

[2] A.Guyton; Medical physiology, W.B.Saunders Company, Edition, 927- 928 **(2000)**.

[3] OSHA; electronic publication at.http://www. osha. Gov /index .html, **(2011)**.

[4] V.Sarwate; Eleactromagntaic field and waves, Wiley Eastern, Edition, **(1993)**.

[5] E.T.Yeh; Nursing Assistant Fundamentals, Mc.Hill, **(2007)**.

[6] K.Hossein; The Role of Bright Light during Night Work on Stress and Health Status of Shift Work Nurses, Iranian Occupational Health Association, **(2009)**.

[7] S.Pandi-Perumal, V.Sirnivasan, G.Maestroni, D.Gardinali, B.Poeggleler, R.Hardeland; Melatonin Nature Most Versatile Biological Signal FEBS, **273(13)**, 2813-38 **(2006)**.

[8] G.Joshua; Room light before Bedtime May impact sleep Quality, blood pressure and Diabetes Risk, JCEM, **(2011)**.

[9] A.F.Hayajneh; Effect of Night Shift on Nurses Working in Intensive Care Units at Jordan University Hospital Euro Journals, **23(1)**, 70-86 **(2008)**.

[10] In –Young Yoon, Do-Un Jeong, Ki-Bum Kwon, Sang-Bum Kang, and Byoung-Gun song; Bright light

exposure atnight and light attenuationinthe morning improve adaptation of nightshift workers, Journal sleep, **25(3)**, 351-356 **(2002)**.

[11] I.Mcintyre, T.Norman, G.Burrowes, S.Armstrong, Human Melatonin Suppression by light is Intensity Dependent, Journal of pineal Res., **6(2)**, 149–156 **(1989)**.

[12] N.H.Peng, H.C.Mao, Y.C.Chen, Y.C.Chang; Effect of Light Intensity on the Physiological Parameters of the Premature Infant, Pub.Med., **9(3)**, 43-333 **(2001)**.

[13] A.Schutz; What is oxygen saturation, science, 281, 664 **(1982)**.

[14] K.Michael; Acute hyperoxia prevents arteriovenous intrapulmonary shunting during submaximal exercise in healthy humans, FASEB J, **21(6)**, 1438 **(2007)**.

[15] WHO; Hypertension fact sheet, Department of Sustainable Development and Healthy Environments, **(2011)**.

[16] A.H.Richard; Biochemistry, 4th Edition, North American, Lippincott Williams and Wilkins pub, 93–95 **(2005)**.

[17] R.E.Westfal, G.R.Pesola, H.R.Pesola, M.J.Nelson; The normal difference in bilateral indirect BP recordings in normotensive individuals, American Journal of Emergency Medicine, **19(1)**, 5–43 **(2001)**.

[18] Elert, Glenn; Temperature of a Healthy Human (Body Temperature).The Physics Fact book, Retrieved, 08-22 **(2007)**.

[19] W.G.Cochran; Sampling techniques, 3rd Edition, New York Willy and son publication, **(1997)**.

[20] M.M.Abdel-Ali, I.R.Abdel-Raziq, Z.N.Qamhieh; Noise Pollution in Factories in Nablus City, ActaAcustica, **89**, 913-916 **(2003)**.

[21] I.R.Abdel-Raziq, M.S.Ali-Shtayeh, H.R.Abdel-Raziq; Effects of noise pollution on Arterial Blood Pressure, Pulse Rate and Hearing Threshold in School Children, Pakistan Journal of Applied Science, **3**, 717-723 **(2003)**.

[22] Z.N.Qamhieh, M.Suh, I.R.Abdelraziq; Measurment of noise pollution in the community of Arraba, AcusticaActaAcustica, **86**, 376-378 **(2000)**.

[23] R.M.Sadeq, Z.N.Qamhieh, I.R.Abdelraziq; Effect of noise pollution on arterial blood pressure and heart pulse rate of workers in the hospitals of Nablus City-West Bank, J.Med.Sci., 1-4 **(2012)**.

[24] Dana N.Ibrahim, Zaid N.Qamhieh, Issam R.Abdel-Raziq; Health Effects of Occupational Noise Exposure in the Range (90-110) dB (A) Especially on Blood Oxygen Saturation of Workers in Selected Industrial Plants, Environmental Science: An Indian Journal, Accepted for publication, **(2013)**.

[25] S.R.Pandi-Perumal, V.Srinivasan, G.J.M.Maestroni, D.P.Cardinali, B.Poeggeler, R.Hardeland; Melatonin Nature's most versatile biological signal, FEBS Journal, **273(13)**, 2813-2838 **(2006)**.

[26] Z.Zamanian, H.Kakooei, S.M.T. Ayattollahi, M.Dehghani; Effect of Bright Light on Shift Work Nurses in Hospitals", Pakistan Journal of Biological Sciences, **13**, 431-436 **(2010)**.