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EFFECT OF SHIFT WORK ON BODY MASS INDEX AND OTHER BIOCHEMICAL CHANGES

By

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Abstract:

Introduction: Shift work is associated with increased incidence of obesity and other features of the metabolic syndrome. Health problems in shift workers are caused by several factors, one of these factors is the stress hormone cortisol. **Aim of the work:** to assess the association between night shift work and the changes in body mass index (BMI), fasting blood glucose, lipid (total cholesterol, HDL, and triglycerides) levels, cortisol hormone secretion, uric acid blood level and salivary cortisol level. **Materials & Methods:** this study was conducted on 160 male security personnel, their age ranging from 35 to 40 years in Cairo . Regarding the work schedule 80 subjects worked daytime for 8 hours, whereas 80 individuals worked only night shift for 12 hour with one day off, for at least continuous 5 years. **Results:** the results showed no significant difference between night shift and day workers as regard age and working years. As regard body mass index (BMI) there was highly significant difference (<0.001) between night and day workers. There was no significant difference between night and day shift workers as regard total cholesterol level, triglycerides, and fasting blood glucose (P< 0.05) where as there is a significant difference between night and day shift workers as regard HDL –cholesterol (P<0.05) and a highly significant difference between night and day shift workers as regard uric acid blood level (P<0.001).A significant difference was detected in salivary cortisol levels among night shift workers where the salivary cortisol level is higher in the evening than in the morning, also there is a significant difference in salivary cortisol level among day shift workers where the salivary cortisol level is higher in the morning than in the evening (P<0.05). **Conclusion:** Our results suggest an association between long-term shift work and increased body mass index, elevation cortisol level, HDL–cholesterol, fasting blood glucose and uric acid level. Further studies are needed to understand the biological mechanisms involved and the complex behavioral and social adaptations experienced by night-shift workers. Regular screening health programs should be done to maintain the health of shift workers.

Introduction

According to International Labor Office, shift work is defined as; "a method of work organization under which groups or crews of worker's succeed each other at the same work stations to perform the same operations, each crew working a certain schedule or shift". It has been associated with increased incidences of obesity and other features of the metabolic syndrome, such as hypertension, hyperlipidemia, and insulin resistance (De Bacquer et al.,2009) The proportion of larger companies using shift workers has increased, with 51.2% of companies with at least 1,000 employees having adopted a shift work schedule that includes fixed night work and alternating shift work (Yasushi Suwazono., et al 2008).

Health problems in shift workers are caused by several factors, one of these factors is the stress hormone cortisol. Cortisol is secreted in a circadian rhythm with high levels in the early morning and low levels in the evening and night. Pathologically high levels of cortisol are associated with abdominal obesity, insulin resistance, hypertension, and dyslipidemia, all features of the metabolic syndrome (Blok & de Looze , 2011). Changes in behavioral cycles due to shift work could result in disruption of the circadian rhythm of cortisol secretion, resulting in hyperactivity of the hypothalamic-pituitary-adrenal axis, leading to long-term elevated cortisol levels. Several studies have investigated cortisol rhythms in shift workers and found that the cortisol awakening response is decreased and evening cortisol levels are increased during shift work (Folkard, 2008)

Elevations in the serum levels of cholesterol, glucose, uric acid, and potassium have been reported during the first week after a night shift, and this impairment could not be explained by changes in dietary habits or other lifestyle variables. (Theorell & Akerstedt 1976).The effect of shift work on body weight has been investigated in previous studies, several of which demonstrated the tendency to become overweight, other studies have also reported that elevated serum triglycerides and lower concentrations of high-density lipoprotein cholesterol tend to occur more frequently in association with shift work than with fixed daytime work (Karlsson et al., 2001).

Many studies have reported an association between shift work and abnormal glucose metabolism (Suwazono et al, 2006), the results showed an association between shift work and increase in body mass index which may be due to the changes in the level of the stress hormone cortisol secretion also this study

showed some biochemical changes among night shift workers.

Aim of the work

To assess the association between night shift work and the changes in body mass index (BMI), fasting blood glucose, lipid (total cholesterol, HDL, and triglycerides levels cortisol hormone secretion, uric acid blood level and salivary samples to measure the serum cortisol level

Materials and Methods

This is a cross sectional study consisted of a total of 160 male security personnel their age ranging from 35to 40 years in Cairo with the same socio-economic standard. The study was conducted from January to June, 2012. Regarding the work schedule 80 subjects worked daytime for8 hour, whereas 80 individuals worked only night shifts for 12hour with one day off, for at least continuous 5years. All participants gave a written informed consent in order to participate in this study.

A questionnaire was done for all subjects including the type of job schedule (i.e., shift work or day work), family history and smoking habits.Subjects with any chronic illness (diabetes mellitus, endocrinal disorders, and chronic renal diseases) or smoking were excluded from this study

Sampling

A fasting blood sample was drawn from an antecubital vein for the measurement of blood glucose, lipid (total cholesterol, HDL, and triglycerides) levels, uric acid blood level.

Salivary samples were collected at 8.00 o'clockin the evening and at8.00 o'clock in morningfor the entire study group in order to measure theserum cortisol level, the participants were informed about the collection method of the salivary sample (Salivette-Sarstedt), they were asked to contributetwo saliva samples. They were asked in advance not to eator drink (except for water) 1 hour before saliva collectionto minimize possible food debris and stimulation ofsalivation.

The entire participants were subjected to the following:

1.Measurement the body mass index (BMI) it was calculated as weight (kilograms) divided by height squared (meters2), based on BMI classification: normal individuals having a BMI under 25 kg/m^2, overweight individuals with a BMI of 25–30 kg/m^2, and obese individuals with a BMI over 30 kg/m^2.

2. Determination of Plasma glucose level was estimated by God-PAP enzymatic colorimetric method using Biomerieux test kit, Cat. No.5 127(Trinder 1969).

3. Serum total cholesterol level was measured by quantitative colorimetric method at 340nm and 37°C (Cat. No. 94545, BioAssay Systems, Enzy ChromTM, USA) (Kayamori et al., 1999).

4. Serum triglyceride level was quantified by colorimetric method (spectrophotometry at=570 nm) (Cat. No. K622-100, Triglyceride Assay Kit, BioVision) (Mcgowan et al., 1983).

5. Serum uric acid level was detected by Quantitative Colorimetric technique at 590nm (QuantiChrom TM Uric Acid Assay Kit (DIUA - 250) (Kamel 2007).

6. Direct assay of cortisol in human saliva was done by solid phase radioimmunoassay (Hiramatsu, 1981). Salivary cortisol was estimated (mcg/dl) due to its stability in saliva for a longer time period and its ease of taking for circadian studies. The salivary cortisol concentration was synchronous with the serum concentration, indicating that the salivary assay could be substituted for the serum assay to assess circulatory rhythmicity across the 24-h time frame. After collection it is important to keep samples cold, in order to avoid bacterial growth in the specimen. Refrigerate samples within 30 minutes, and freeze at or below -20°C within 4 hours after collection. Freezing saliva samples will precipitate the mucins. On day of assay, thaw completely, vortex, and centrifuge at 1500 x g (@3000 rpm) for 15 minutes. Samples should be at room temperature before adding to assay plate (Dorn et al., 2007).

Statistical Analysis:

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 11(SPSS Inc., Chicago, USA). Standard descriptive statistics were used to summarize the hormonal levels and biochemical parameters such as means and standard deviations (SD). Significant differences between mean values of exposed and control groups were statistically analyzed using the Student's t-test. Results were considered significant when p- value < 0.05.

Results

Table1. Sociodemographic Variables in the Study Participants

	Night shift workers	Day workers	P
Age (year)	37.6±1.7	37.8±2.3	>0.05
BMI (kg/m^2)	28.9±3.2	25.2±2.6	<0.001*
Working (year)	5.5±0.7	5.8±2.8	>0.05

*Statistically significant

Table2.Biochemical parameters in the studied groups

	Night shift workers	Day workers	P
Total cholesterol (mg/dl)	196.4±27.3	194.1±30.2	>0.05
HDL-cholesterol (mg/dl)	42.3±6.6	43.6±6.7	<0.05*
Triglycerides (mg/dl)	159.1±62.7	139.9±66.1	>0.05
Fasting blood glucose (mg/dl)	89.2±7.4	86.8±8.5	>0.05
Uric acid (mg/dl)	9.6±1.4	6.3±1.8	<0.001*

*Statistically significant

Table3(a,b): Circadian levels of mean salivary cortisol levels(mcg/dl)during night and day shifts.

Table3a:

	In the morning	At night	p
Night shift	2.5±2.1	3.3±3.3	<0.05*
Day shift	2.2±1.9	1.7±1.3	<0.05*

*Statistically significant.

Table3b:

	Night shift	Day shift	P
At the start of the shift	3.3±3.3	2.2±1.9	<0.001*
At the end of the shift	2.5±2.1	1.7±1.3	<0.001*

*Statistically significant

Table 1 showed sociodemographic variables of shift and day workers, there was no significant difference between nightshift and day workers as regard age and working years. While as regard body mass index(BMI) there was highly significant difference(<0.001) between night (28.9±3.2)and day(25.2±2.6)workers

Biochemical parameters in table 2 showed no significant difference between night and day shift workers as regard total cholesterol level, triglycerides, and fasting blood glucose (P<0.05) where as there is a significant difference between night and day shift workers as regard HDL –cholesterol (P<0.05) and a highly significant difference between night and day shift workers as regard uric acid blood level (P<0.001).

Circadian levels of mean salivary cortisol levels during night and day shifts are represented in table (3 a, b).Table 3a showed a significant difference in salivary cortisol level among day shifts workers where the salivary cortisol level is higher in the morning than in the evening (P<0.05).

Table 3b showed a significant difference in salivary cortisol levels between night and day shifts workers at the start and the end of the shift (P<0.001).

The result of this study showed that the circadian patterns of cortisol during night shift were altered in night and morning phase from that of the normal pattern. Also the results showed a significant difference in salivary cortisol levels among night shift workers where the salivary cortisol level is higher in the evening than in the morning (p<0.05), there is a significant difference in salivary cortisol level among day shift workers where the salivary cortisol level is higher in the morning than in the evening (P<0.05). Our results also showed a highly significant difference in salivary cortisol levels between night and day shifts workers at the start and the end of the shift (P<0.001)

Discussion:

This study performed to investigate the effect shift work on the BMI, some biochemical parameters: fasting blood sample, lipid (total cholesterol and triglycerides) levels, uric acid blood level,and salivary samples to measure the serum cortisol level

This study showed that BMI is higher in shift workers than day workers (highly significant P<0.001). These results are consistent with the study done by Geliebter et al, 2000 who detected that weight gain occurs in late-shift workers (evening and night). Increase BMI in shift workers may refer to certain factors such as higher calorie intake, changes both in dietary habits (such

as eating fewer meals and more snacks) and in the circadian distribution of food intake, lower physical exercise and changes in sleeping habits (Geliebter et al, 2000). Also Van Amelsvoort et al 1999 showed that employees involved in shift working for more than 5 years had significantly higher BMI than those with no shift work experience.

In contrast to this result; Amelsvoort et al 2004 showed that BMI decreased significantly among shift workers when they were compared with day time workers after 1 year from the start of a new job.

As regard biochemical changes our results showed that the total cholesterol and HDL-cholesterol concentrations were not different between shift workers and day workers .This is in accordance with DiLorenzoel, 2003 and with Chun Chieh Chen et al,2010 who stated that there is no statistical difference between shift workers and day workers as regard total cholesterol ,HDL-cholesterol and LDL-cholesterol.

In contrast to our study Boggild & Knutsson 1999, reported increased concentrations of triglycerides among shift workers compared with day workers in four out of 12 studies. The large variation of circadian rhythm for triglycerides and the measurement of individual blood samples at different times could be one of the reason for these inconsistencies (Rivera et al., 1994).Theorell and Åkerstedt, 1976 study stated that a significant elevations in the serum levels of cholesterol, was observed during the first week after a night shift . Also Anders et al, 1988 showed that shift workers had significantly higher levels of serum triglycerides (1.61mmol/1) versus (1.43 mmol/1) in day workers.

As regard fasting blood glucose level there was no significant difference between night shift workers and day workers($P>0.05$) in our result .This is in accordance with Lorenzo et al ,2003 who stated that there is no statistical difference between shiftworkers and day workers as regard fasting blood glucose.

The results of our study showed a highly significant difference between night shift workers and day workers as regard serum uric acid level ($P>0.001$). This is similar to the work done by Mirei Uetani who concluded that in the group that shifted from day work to night work, serum uric acid increased significantly after 3 weeks compared to their values before they began night work. The possible mechanism for alterations in serum uric acid could be that shift work, may increase due to the effect of stress (Mirei Uetani, et al, 2006)

This is in contrast to Dochi et al,2009 who showed that uric acid was significantly

higher in day workers compared with alternating shift workers (P<0.005).

Night shift workers are awake when they are supposed to sleep and attempt to sleep in day time when they are normally supposed to be awake. They have a higher incidence of poorer sleep and its complications (Hennig et al, 1998).The blood cortisol level has a normal diurnal variation with an increase during early morning and decreased at night. Cortisol, a reliable indicator of stress, displays pronounced variation across the time-of-the day with high levels in the morning and low around midnight, stress may alter intensity of secretion of cortisol and circadian pattern of the hormone (Singh et al, 1998).

Changes in circadian rhythm of salivary cortisol secretion in shift workers as indicated by the results of this study is in accordance with Laura et al 2011, who stated that shift workers had higher hair cortisol levels than day workers: 47.32 pg/mg hair [95% confidence interval (CI) = 38.37–58.21] vs. 29.72 pg/mg hair (95% CI = 26.18–33.73) (P< 0.001). Also our results are in agreement with Baby et al, 2011 who showed that salivary cortisol levels were lowest in early morning, increased at midnight and further increased in the afternoon during night shifts.

The results of our study showed a very interesting finding as it showed both elevation of cortisol level and increased BMI among night shift workers , as cortisol may have a role in increasing the body weight which may affect the health of shift workers and has a negative aspect on their health .This finding is supported by Baby et al ,2011 who found that increased long-term hair cortisol levels in shift workers may contribute to the increased prevalence of obesity and cardiovascular risk that is found in shift workers(Baby et al , 2011).

Conclusions

Our results suggest an association between long-term shift work and increased body mass index, elevation cortisol level, HDL–cholesterol, fasting blood glucose and uric acid level.Further studies are needed to understand the biological mechanisms involved and the complex behavioral and social adaptations experienced by night-shift workers.Regular screening health programs should be done to maintain the health of shift workers.

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