

Evaluation of the Effect of Shift Work on Serum Cholesterol and Triglyceride Levels

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Background: Working outside daylight hours (7 am to 7 pm) is called shift work. Shift work is a common practice in many industries and factories such as steel industries, petroleum industries, power plants, and in some services such as medicine and nursing and police forces, in which professionals provide services during day and night.

Objectives: Considering the contradictory reports of different studies, we decided to evaluate the effect of shift work on cholesterol and triglyceride (TG) levels through a historical cohort on steel industry workers.

Patients and Methods: This retrospective cohort study was performed on all the staff of Isfahan's Mobarakeh Steel Company between years 2002 and 2011. There were 5773 participants in this study. Data were collected from the medical records of the staff using the census method. For analysis of data, generalized estimating equation (GEE) regression was used.

Results: The results showed a significant difference in cholesterol levels between shift workers and day workers on the first observation ($P < 0.001$), yet no such difference was observed for TG ($P = 0.853$). Moreover, the results showed that the variables of age, work experience and BMI were not similar between shift workers and day workers. Therefore, to remove the effect of such variables, we used GEE regression. Despite the borderline difference of cholesterol between regular shift workers and day workers, this correlation was not statistically significant ($P = 0.051$). The results for TG also showed no correlation with shift work.

Conclusions: According to the findings of this study, there is no relationship between shift work and changes in serum TG and cholesterol. The lack of relationship can be due to shift plans for shift workers, nutrition, or the "Healthy Heart project" at Isfahan Mobarakeh Steel Company.

Keywords: Shift Work; Cholesterol; Triglycerides; Cohort Studies; GEE

1. Background

Shift work is a common practice in many industries and factories such as steel industries, petroleum industries, power plants, and in some services such as medicine and nursing and police forces, in which professionals provide services during day and night. Some of the professionals in these services have to sleep during the day, when the community is active, and work at night, when most people are asleep (1, 2). There is no clear definition for shift work. Some define it as a pattern of work hours different from the routine pattern, which is very general; according to this definition, shift work includes regular shift work and rotating shift work (3). By another definition, working outside daylight hours (7 am to 7 pm) is called shift work; there are diverse scheduled programs of shift work depending on the work site. Workers may be scheduled on rotating shifts or regular night shifts (4). About 20% of workers in industrial countries work rotating or regular night shifts (1, 2). Rotating shift work includes a wide range of time tables and

requires rotating shifts and change according to a certain time table. These shifts can be continuous for 24 hours a day or semi continuous including two or three shifts per day with or without weekends. Workers in turn take part in all shifts of a certain system. Workers who work at night or rotating shifts are very in terms of possible disruption of family and social connections (5). In developed countries, which have regular time schedules, work hours are 40 hours a week and eight hours a day. In some countries, work is scheduled as four ten-hour shifts. Research has shown that workers who work ten hours a day, experience more fatigue compared to workers who work eight hours a day. Unfortunately, night shift is inevitable in some professions (6). Different studies have confirmed a direct relationship between work shift and the following complications, cardiac disease (7-10), lipid profile disorders (2, 11), weight gain (12-14) and metabolic disorders (7, 15, 16). A cross sectional study on 2610 men aged 50-60 years showed

that systolic blood pressure was considerably higher in shift workers than day workers. Moreover, the serum level of triglyceride (TG) is significantly higher in night versus day workers. Therefore, it can be concluded that there is a significant correlation between shift work, hypertension and the serum level of TG (17). A cross sectional study on 361 shift workers and 240 day workers showed no difference in BMI, cholesterol and blood pressure between the two groups. Moreover, regression analysis revealed a significant correlation between shift work and serum TG. Finally, another study concluded that shift work was associated with a number of coronary risk factors (18). A study on 22 male workers, who worked three shifts, showed that blood cholesterol and low-density lipoprotein (LDL) in third shift workers (afternoon) were higher than other shift workers (19).

In a 14-year retrospective cohort, which was performed on 6886 Japanese steel workers (4079 day workers and 2807 shift workers), the results showed an increase in serum cholesterol of shift workers (20, 21).

It is important to mention that some studies have reported the reverse; for example, a cross sectional study on 148 Malaysian workers failed to show any significant correlation between serum total cholesterol, LDL, TG, glucose and BMI (22). A study on 1351 men, including 877 day workers and 474 shift workers, reported no significant difference in total cholesterol and systolic blood pressure between the two groups (23). A longitudinal study on 488 Italian garbage collectors (157 regular day workers, 12 regular night workers and 319 workers who first worked during the day and then at night) showed that BMI, total cholesterol, and TG was higher in night workers (regular and first day then night workers) compared to day workers (7). Another cross sectional study on 319 Italian workers showed no significant difference in high-density lipoprotein (HDL)-cholesterol, total cholesterol, and TG between day workers and shift workers (24). A longitudinal retrospective study also failed to demonstrate any difference in cholesterol and HDL between shift and day workers (25).

2. Objectives

Due to contradictory reports of different studies, we decided to evaluate the effect of shift work on cholesterol and TG through a historical cohort study on steel industry workers.

3. Patients and Methods

This retrospective cohort study was performed on the staff of Isfahan's Mobarakeh Steel Company between years 2002 and 2011 using the census method. There were 5773 participants in this study. Data were collected from the medical records of the staff using the census method. The inclusion criterion was permanent employment between years 2002 and 2011 with at least two years experience. The exclusion criteria included, working part-time, death, retirement or dismissal from work and incomplete records.

Blood cholesterol and TG were measured using standard methods and calibrated tools at the same laboratory. Weight and height were measured by a physician.

The variable of shift work in this study was defined as regular shift work, weekly rotating shift work and day work. Regular shift workers worked two day-shifts, two evening-shifts, and two night-shifts, and had two days off in a rotating fashion. Weekly rotating shift workers worked three morning-shifts and three evening-shifts in a rotating fashion and had one day off every two weeks. They always had Fridays off, as well. Day workers worked Saturdays through Wednesdays, from morning to evening, and had Thursdays and Fridays off. Morning, evening, and night shifts started at 7 am, 3 pm, and 11 pm, respectively. This study was approved by the Ethics Committee of Islamic Azad University and Baqiyatallah University of Medical Sciences.

3.1. Data Analysis

Data were analyzed using the SPSS 18 software. Chi square and ANOVA (if needed Kruskal Wallis test) were used to compare percent and mean values of each base line variable according to the shift. Also generalized estimating equations (GEE) were used to model correlated and longitudinal data for investigating the predictors of longitudinal changes in cholesterol and TG after controlling for confounding factors (age, work experience, BMI, marriage, education, and smoking status). P values of less than 0.05 were considered significant.

4. Results

This study was performed on 5773 male workers from Isfahan's Mobarakeh Steel Company. The mean age and work experience of the participants was 34.23 ± 5.91 and 8.80 ± 5.09 years, respectively. Of all the participants, 5365 (92.9%) were married, 842 (14.6%) were smokers, and 376 (6.5%) were hypertensive. Regarding education, 883 participants (15.3%) had junior high school education, 3442 (59.6%) had high school education, 648 (11.2%) had an associate degree, and 800 participants (13.9%) had a bachelor's degree or higher. Moreover, 2854 of the candidates (49.4%) were regular shift workers, 2557 (44.3%) were day workers and 362 (6.3%) were weekly rotating shift workers.

Table 1 presents mean age, work experience, BMI, cholesterol and TG of the participants based on their work pattern on the first observation. Based on the information of Table 1, the mean age, work experience, cholesterol and BMI were higher in day workers versus regular and weekly rotating shift workers.

Considering the inequality of the variables of age, work experience, and BMI on the first observation and to control these variables in the final analysis, we used a regression model to evaluate the relationship between the pattern of shift work and cholesterol and TG. The results of the analysis are presented in Table 2. The results showed no significant correlation between the pattern of shift work and changes in blood TG and cholesterol.

Table 1. The Variables of Age, Work Experience, BMI, Cholesterol, and Triglyceride in Participants Based on their Work Pattern on the First Observation ^{a,b}

Variable	Work Pattern			P Value
	Regular Shift Worker	Day Worker	Weekly Rotating Shift Worker	
Age, y	33.55 ± 5.7	34.92 ± 5.99	34.78 ± 5.96	< 0.001
Work experience, y	8.74 ± 4.88	8.74 ± 5.34	9.71 ± 4.86	< 0.001
Cholesterol, mmol/L	183.41 ± 34.98	186.93 ± 34.53	183.36 ± 32.62	< 0.001
TG	166.34 ± 127.07	164.87 ± 111.91	163.35 ± 131.53	0.853
BMI	24.51 ± 3.14	24.59 ± 3.18	23.99 ± 2.92	0.004

^a Abbreviations: BMI, Body Mass Index; TG, Triglyceride.

^b Data are presented as Mean ± SD. P value based on ANOVA or Kruskal Wallis test.

Table 2. A Summary of Generalized Estimating Equation Results for the Effect of Shift Work on Blood Cholesterol and TG After Controlling for Confounding Factors ^{a,b}

Work Shift Effect	Beta Coefficient	SE	95% CI		Wald test	Test	
			Lower	Upper		Df	P value
Cholesterol							
Regular	-1.812	0.9181	-3.612	0.012	3.898	1	0.051
Weekly rotating	-1.835	1.7620	-5.289	1.619	1.084	1	0.298
TG							
Regular	-.945	2.7231	-6.283	4.392	0.121	1	0.728
Weekly rotating	-2.769	5.2060	-12.973	7.434	0.283	1	0.595

^a Abbreviations: SE, Standard Error; CI, Confidence Interval.

^b Data are regarded in comparison with the day worker group.

5. Discussion

Table 1 shows a significant difference in cholesterol between shift workers and day workers on the first observation ($P < 0.001$) but no such difference was observed for TG ($P = 0.853$). Moreover, the results of Table 1 show that the variables of age, work experience and BMI were not similar between shift workers and day workers. Therefore, to remove the effect of such variables, we used the GEE regression and nine-year follow-up data of the workers to evaluate the relationship between shift work and two variables of cholesterol and TG. Table 2 shows the results of GEE regression. According to Table 2, despite the borderline difference of cholesterol between regular shift workers and day workers, this correlation was not statistically significant ($P = 0.051$). The results for TG also showed no correlation with shift work. The lack of relationship between shift work and cholesterol and TG is in contrary with some previous studies (2, 7, 11, 17, 19-21, 26-29) while it is compatible with some other studies (18, 22, 24, 25, 30-37). A study that reported similar results was conducted by Nazri et al. In this cross sectional study that was performed on 148 Malaysian workers, the prevalence of hypertension (systolic blood pressure more than 140 and diastolic blood pressure more than 90 mmHg) was higher in shift workers when compared to day workers. Moreover, no significant correlation was found regarding total cholesterol, LDL, TG, blood glucose and BMI.

Only the mean HDL was significantly higher in shift workers than the day workers (22). In a ten-year retrospective study on 1529 male workers of a zipper company, shift work caused an increase in BMI. Moreover, blood pressure and serum cholesterol were not different between day workers and shift workers (35). This finding was also reported by a six-year retrospective study and no correlation was reported in cholesterol and HDL between day workers and shift workers (25).

A cross sectional study, on 319 participants in Italy, showed that obesity and systolic hypertension (HTN) were more prevalent in shift workers when compared to day workers. In this study, no relationship was found in TG, HDL, total cholesterol, and diastolic blood pressure (DBP) between shift workers and day workers (24).

In another case-control study on 57 shift and day workers in which variables such as age, smoking, and type of employment (employee or worker) were paired, no significant difference was seen in blood pressure, BMI, and cholesterol between day workers and shift workers (30).

A study on 58 nurses (30 shift workers and 28 day workers), during a period of 18 months, showed that shift workers had a higher systolic blood pressure and weighed more than the day workers. This study also demonstrated no correlation between TG, cholesterol and HDL (31).

A cross sectional study on 12 shift workers and 13 day

workers using pre and post test, during a six-month period, showed no significant difference in total cholesterol and TG between the two groups (34). This could be due to the health worker effect, which means healthier people are hired in more difficult jobs. For example, Gholami et al. reported that the BMI of shift workers was less than day workers while in similar studies, shift workers were found to be more obese than day workers. They reviewed the process of hiring workers and stated that healthier people were recruited more for shift work than day work (32).

Another reason for the lack of any relationship is the "Healthy Heart project" at Mobarakeh Steel Company (33, 38). In this project, obese and hypertensive workers receive diet consultation and sometimes treatment. This project has helped decrease obesity and hypertension in the company through developing a menu of diet foods in the food program of the workers.

However, it is important to mention that the effect of shift work on workers is also related to the type of job, personal characteristics, social and organizational environment of the workplace and the specifications of the shift work program (13). Therefore, the lack of relationship can be attributed to other reasons such as the flexibility of the shifts, and more time off for shift workers versus day workers. On the other hand, not all the studies that reported a correlation between shift work and cholesterol had similar work environments and definitions for shift work (4). Moreover, the rotation plan in shift work differs and different studies have evaluated different types of jobs. Finally, confounding factors that affect cholesterol, such as lifestyle, physical activity, smoking, etc. are not similarly controlled in different investigations (4, 39).

The advantages of this study were its retrospective cohort design, use of GEE regression to analyze data, an appropriate sample size, homogeneity of the study population, and calculation of BMI in the clinic with the measurement of weight and height by physicians.

According to the findings of this study, there is no relationship between shift work and changes in serum TG and cholesterol. The lack of relationship can be due to shift plans in shift workers, nutrition, or the "Healthy Heart project" at Isfahan's Mobarakeh Steel Company.

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