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The Moderating Effect of Shift Work on Lipid Pathway: An Application of Multi-Group Path Analysis Model

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Abstract

Background: Previous studies have reported conflicting results concerning the association between shift work and variables such as blood pressure and lipid profile.
Objectives: The present study aimed to examine the moderating effect of shift work on lipid profile and blood pressure.
Methods: This cross-sectional study was done on steelworkers who worked in Esfahan's Mobarakeh Steel Company (EMSC) in the year 2017. In this study, workers were selected using random cluster sampling to investigate the moderating effect of shift work on lipid profile using the path analysis model in AMOS software.
Results: A total of 1549 workers (including 926 (60%) shift workers and 623 (40%) day workers) with a mean age of 24.17 ± 6.11 years participated in this study. The path analysis model showed a good fit index (RMSEA = 0.012, P = 0.010). The path analysis results revealed that shift work moderating effect caused a decrease in the relationship between Triglyceride (TG) and Low-Density Lipoprotein (LDL) and between TG and LDL but increased the relationship between TG and Diastolic Blood Pressure.
Conclusions: Our findings showed a new evidence that shift work could have a moderating effect on blood pressure and lipid profile.

Keywords: Blood Pressure, Lipid Profile, Lipoproteins, Moderator, Path Analysis, Shift Work, Steel Worker, Triglycerides

1. Background

Industrialization in the world especially in steel industries has led to the widespread adoption of shift-work scheduling (1).

Shift work is an unusual pattern of work in comparison with Workday. This pattern in many industrial, economic, and service activities is an integral part of the provision of services (2, 3).

Previous studies have shown that nutrition shift work (3, 4), physical activity (4-6), obesity (7-9), blood pressure (BP) (10, 11), blood lipid variables (like triglyceride (TG), cholesterol (CHOL), Low- Density Lipoprotein (LDL), High-Density Lipoprotein (HDL), and Fasting Blood Sugar (FBS)) are the most common risk factors for cardiovascular diseases (12-14).

For this reason, studying the association between the risk factors such as shift work and blood pressure, lipid variables, obesity, and lipid profiles is important.

The results of our study documented the strong impact of shift work on body weight gain, the risk of obesity, and blood pressure. These findings are in line with many studies that have reported a relationship between shift work and other lipid variables such as blood pressure (15-17) ↑, (18-20) ↓, Low-Density Lipoprotein (18-21) ↑, (22) ↓, High-Density Lipoprotein (23) ↑, (21, 24) ↓, Waist Circumference (16, 25), Body Mass Index ↑ (26-29), Fasting Blood Sugar (ineffective) (30), cholesterol ↑ (1), ↓ (31), triglyceride ↑ (32), ↓ (33), age↑ (34), and weight ↑ (5, 7-9).

2. Objectives

Given the importance of the issue, this study aimed to investigate the moderating effect of shift work on lipid profile and blood pressure.

3. Methods

A cross-sectional study that was approved by the Medical Ethics Committee of Tarbiat Modares University (code number: IR.TMU.REC.1395.398) was conducted on the workers of Esfahan's Mobarakeh Steel Company (EMSC) from

Table 1. Correlation Between Lipid Variables According to Day and Shift Workers

Day Workers										Shift Workers								
FBS	**CHOL**	**LDL**	**HDL**	**TG**	**SBP**	**DBP**	**Weight**	**WC**		**WC**	**Weight**	**DBP**	**SBP**	**TG**	**HDL**	**LDL**	**CHOL**	**FBS**
								0.84[a]	**Weight**	0.80[a]								
							0.21[a]	0.22[a]	**DBP**	0.21[a]	0.20[a]							
						0.64[a]	0.14[a]	0.19[a]	**SBP**	0.28[a]	0.23[a]	0.66[a]						
					0.06	0.03	0.18[a]	0.16[a]	**TG**	0.23[a]	0.20[a]	0.125[a]	0.10[a]					
				-0.14[a]	0.00	-0.06	-0.14[a]	-0.09[b]	**HDL**	-0.13[a]	-0.13[a]	-0.04	-0.07[b]	-0.15[a]				
			0.54[a]	0.10[b]	0.05	0.01	0.06	0.12[a]	**LDL**	0.06	0.03	0.06	0.05	0.16[a]	0.45[a]			
		0.86[a]	0.57[a]	0.31[a]	0.06	-0.01	0.07	0.12[a]	**CHOL**	0.09[a]	0.07[b]	0.09[a]	0.09[a]	0.40[a]	0.47[a]	0.85[a]		
	0.06	0.05	0.05	0.07	0.13[a]	0.13[a]	0.12[a]	0.16[a]	**FBS**	0.10[a]	0.06	0.06	0.07[b]	0.12[a]	0.02	0.06	0.10[a]	
0.15[a]	0.06	0.07	0.11[a]	-0.01	0.09[b]	0.06	-0.11[a]	0.09[b]	**Age**	0.13[a]	-0.06	0.07[b]	0.10[a]	-0.01	0.06	0.05	0.05	0.15[a]
89.94	183.06	106.84	46.42	154.29	118.05	77.17[b]	80.20	92.58	**Mean**	92.33	79.51	78.24[b]	119.26	154.82	46.36	107.90	185.94	90.82
21.26	35.33	23.26	8.77	100.24	11.71	8.20	12.09	8.76	**SD**	9.07	12.23	8.05	12.57	102.88	9.37	25.02	36.64	21.10

Abbreviations: CHOL, Cholesterol; DBP, Diastolic Blood Pressure; FBS, Fasting Blood Sugar; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; SBP, Systolic Blood Pressure; TG, Triglyceride; WC, Waist Circumference.

[a] $p < 0.001$.

[b] $p < 0.05$.

January 1, 2017, until December 31, 2017 using a random cluster sampling method, in which the work area first was selected, and then the workers in this area were selected using simple sampling.

The inclusion criteria included official employment in the study year with at least two years of work experience, and the exclusion criteria included dismissal or unwillingness to participate in the study. The sample size was calculated as 1532 cases using G*Power software ($\alpha = 5\%$, $\beta = 95\%$, effect size = 0.20, n1 = 1.5 × n2, and dropout rate = 15%) (35). In this study, blood pressure was measured in both arms in a sitting position after a five-minute rest using a calibrated mercury sphygmomanometer. In addition, laboratory variables were measured using the calibrated equipment. The scheduled shift time is presented in Gholami Fesharaki et al. study (18).

3.1. Data Analysis

In this study, a multi-group path analysis model (36) was employed in AMOS version 18 software. In the path analysis, GFI > 0.9, RMSEA < 0.05, and RCS < 2 were considered as the good fit indices (37). P values of less than 0.05 and K-S test were used for statistical significance and data normality, respectively.

4. Results

This study was conducted on 1549 male workers (including 926 (60%) shift workers and 623 (40%) day workers) with a mean age of 43.14 ± 6.08. In Table 1, the correlation between the variables used in the study is reported based on the shift and day workers. The data revealed that the correlation between the majorities of variables was significant. The result of path analysis is presented in Table 2 and Figure 1. In this case, the path analysis indicated excellent goodness of fit results for the data. As can be seen in this table, all betas for direct effect had a significant relationship with the dependent variable. Results also showed that working in shifts tends to reduce the association between triglyceride and cholesterol as well as between triglyceride and low-density lipoprotein but increased the association between triglyceride and diastolic blood pressure.

5. Discussion

The results of this study showed the moderating effect of shift work on three path coefficients (triglyceride → cholesterol, triglyceride → low-density lipoprotein, and triglyceride → Diastolic Blood Pressure) in our model. Our findings showed that shift work tended to reduce the association between triglyceride and cholesterol and between

Table 2. Relationship Between Variables According to Shift and Day Workers[a]

Role of Variable			Total	Shift Workers	Day Workers	P Value
Independent	→	Dependent				
Age	→	FBS	0.152***	0.149***	0.153***	
Age	→	WC	0.112***	0.091*	0.131***	
Age	→	HDL	0.052*	0.071*	0.036	
Age	→	Weight	-0.177***	-0.186***	-0.169***	
WC	→	TG	0.198***	0.156***	0.227***	
WC	→	Weight	0.061*	0.858***	0.824***	
WC	→	LDL	0.838***	0.104*	0.026	
WC	→	SBP	0.242***	0.192***	0.273***	
TG	→	HDL	-0.127***	-0.129**	-0.123***	
TG	→	CHOL	0.713***	0.273***	0.312***	***
TG	→	DBP	0.583***	0.694	0.497*	***
TG	→	LDL	0.121***	0.086*	0.151***	***
Weight	→	DBP	0.11***	0.127*	0.103*	
HDL	→	CHOL	0.713***	0.225***	0.197***	
FBS	→	TG	0.066*	0.047	0.085*	
LDL	→	CHOL	0.713***	0.707***	0.197***	
Goodness of fit			RMSEA = 0.012	GFI = 99%	Relative Chi = 1.439	

Abbreviations: CHOL, Cholesterol; DBP, Diastolic Blood Pressure; FBS, Fasting Blood Sugar; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; SBP, Systolic Blood Pressure; TG, Triglyceride; WC, Waist Circumference.
[a] *P < 0.05 **P < 0.001 ***P < 0.0001.

triglyceride and low-density lipoprotein but increased the association between triglyceride and diastolic blood pressure.

A review of the published papers reveals conflicting findings. For example, Asare-Anane et al. (21), Suwazono et al. (1), Alefishat and Abu Farha (32), and Souza et al. (16) reported a significant association between shift work and low-density lipoprotein, cholesterol, triglyceride, and blood pressure. This is while Kantermann et al. (22), Uetani et al. (31), Akbari et al. (33), and some other studies (33, 37, 38) found no relationship with low-density lipoprotein, cholesterol, triglyceride, and blood pressure.

The conflicting results of previous studies can be attributed to the fact that while shift work might not have a direct effect on blood pressure and lipid variables, not considering it as a moderating variable has caused conflicting results in these studies. Moreover, other factors such as healthy worker effect (18) and running SHIMSCO plan in EMSC (39) may help us to explain the mixed results.

In general, the findings of the present study support the moderating effect of shift work on blood pressure and lipid variables. To assess this relationship more accurately, further cohort studies adjusted for confounding factors such as occupational history, family history, and psychological factors (e.g., occupational stress and job satisfaction) are required. The major strengths of this study were sample homogeneity, large sample size, and applying a powerful statistical model for data analysis, which guaranteed the results of this study. The limitations of this study were that all employees participating in this study were male and since this study was carried out on steelworkers, the results could be more generalized to the heavy industry. In addition, any observed relationship in cross-sectional studies does not imply a causality effect.

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Footnotes

Ethical Considerations: This cross-sectional study was approved by the Medical Ethics Committee of

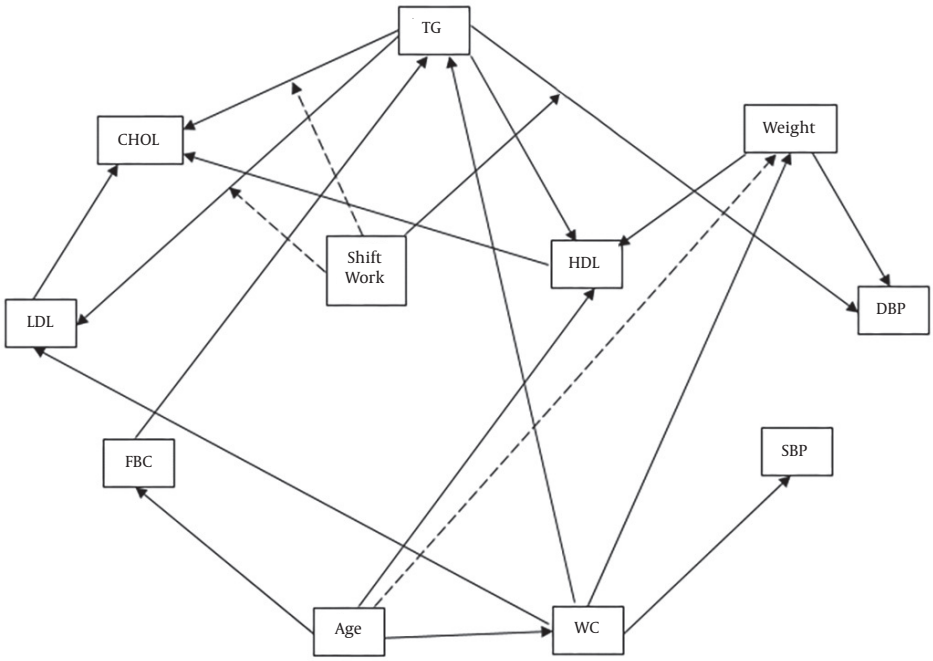

Figure 1. Pathway of blood pressure and lipid variable. Solid and dashed arrows represent increasing and decreasing betas, respectively. (CHOL, Cholesterol; DBP, Diastolic Blood Pressure; FBS, Fasting Blood Sugar; HDL, High-Density Lipoprotein; LDL, Low-Density Lipoprotein; SBP, Systolic Blood Pressure; TG, Triglyceride; WC, Waist Circumference).

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