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Historical cohort study of shift work and blood pressure

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Background	It has been suggested that shift work (SW) is associated with changes in blood pressure (BP). However, studies have reported contradictory results.
Aims	To prospectively examine the association between SW and BP among male workers.
Methods	A historical cohort study, involving workers of Esfahan's Mobarakeh Steel Company, in Iran, was conducted over 14 years. The association between SW, systolic BP (SBP) and diastolic BP (DBP) was investigated after adjusting for body mass index, age, work experience, marriage, smoking and education based on the Bayesian multilevel modelling approach.
Results	The study sample included 5331 male workers. The mean age (standard deviation, SD) was 34.8 (6.6) years and mean work (SD) experience was 9.4 (6.1) years. Among these subjects, 2348 (44%), 340 (6%) and 2643 (50%) were day workers, weekly rotating shift workers and routinely rotating shift workers, respectively. The mean SBP (SD) and DBP (SD) of these workers were 118.7 (8.1) and 73.1 (6.7) mmHg, respectively. After controlling for several confounding variables, there was no significant relationship between SBP and DBP and SW.
Conclusions	No significant association between SW and BP was observed among these three groups (day workers, weekly rotating shift workers and routinely rotating shift workers). Prospective studies, which control for confounding factors, such as the healthy worker effect, occupational history, family history and psychological factors (e.g. occupational stress and job satisfaction), are required to evaluate this further.
Key words	Bayesian multilevel modelling; blood pressure; historical cohort study; Iran; shift work.

Introduction

Shift work (SW) is now common in many economies [1], with many employees working shifts. SW covers a range of work schedules and is used to describe working outside the normal daylight hours of around 07.00 a.m. to 18.00 p.m., the time period in which many individuals in society work a 7–8 h shift. Shift workers might work in the evening, in the middle of the night, overtime or extra-long workdays. They also might work regular days at one time or another. Many shift workers 'rotate' around the clock, which involves changing work times from day to evening or day to night. This might happen at different times of the week or at different times of the month [2]. These irregular work patterns may produce negative effects on an employee's health (particularly in individuals at risk of essential hypertension) and increase the circadian time structure of blood pressure (BP) [3]. Studies have reported different and sometimes inconsistent results regarding the association of SW and BP, with an overall tendency to confirm higher BP in shift workers when compared with day workers [4–7]. Increased BP in shift workers compared with day workers has also been reported in Iranian studies [6,8]. On the other hand, other studies [9–15] have found no significant association between BP and SW and even reported a reverse association [16,17].

Therefore, considering the importance of BP and its association with SW, as well as the inconsistency of the available research in this area, this cohort study was conducted.

Methods

This historical cohort study was conducted at Esfahan's Mobarakeh Steel Company (MSC), in the Esfahan province of Iran. Since all employees at MSC are legally obliged to undergo a periodic annual physical examination, the cohort included workers who attended the periodic physical examinations from 1997 to 2011. The BP of study participants was measured in both arms with participants in a sitting position after 5 min of rest. A calibrated mercury sphygmomanometer was used. Other data recorded included weight, height, age, work experience, history of disease, marital status and smoking habits. Study inclusion criteria included being a permanent employee with at least 2 years of work experience. Retired employees and those who died during the follow-up period were excluded from the study. The study protocol was approved by the Ethics Committee of the Medical School of Tarbiat Modares University.

Employees were divided into three groups: those working routinely rotating shifts, those on weekly rotating shifts and day workers. The routinely rotating and weekly rotating shifts were scheduled with a clockwise rotation plan (two morning shifts, two evening shifts, two night shifts and two days off and three morning shifts, three evening shifts and one day off every 2 weeks, Fridays always off, respectively). The morning, evening and night shifts began at 07.00, 15.00 and 23.00, respectively. Day workers worked from 08.00 to 16.00 on weekdays, with Thursdays and Fridays off.

The association between SW and systolic BP (SBP) and diastolic BP (DBP) was investigated after adjusting for body mass index (BMI), age, work experience, as well as marital status, smoking and educational status, using the Bayesian multilevel modelling [18] approach with vague prior distributions (assuming a normal distribution with mean 0 and variance 100 for the fixed parameters and postulating a gamma distribution with parameters $\alpha = 0.001$ and $\beta = 0.001$ for the variance parameters). Results are based on 100 draws from a Markov Chain Monte Carlo (MCMC) of length 11 000 iterations with a burn-in of 1000 iterations, to characterize posterior distributions for the beta parameters. The statistical analysis was performed using the OpenBUGS version 3.2.2 and R version 2.13.2 statistical software programs. *P* values of <0.05 were considered statistically significant.

Results

During the study period, 6125 workers had a periodic physical examination. Thirteen per cent of workers [$n = 764$; those who were not permanent employees with at least 2 years of work experience ($n = 435$), those who retired during study ($n = 321$) and those who died during the study period ($n = 8$)] were excluded from the study. The final study group was 5331 male workers of whom 3450 (65%), 606 (11%), 1200 (23%) and 75 (1%) were blue collar workers, engineers, administrative and management staff, respectively. Table 1 shows a summary of the different characteristics of the employees by type-of-job schedule.

Age and work experience were significantly higher in weekly rotating shift workers compared with day workers and routinely rotating shift workers, whereas DBP was significantly lower in weekly rotating shift workers compared with day workers and routinely rotating shift workers. The percentage of married employees and those with academic education was significantly higher in day workers compared with routinely rotating shift and weekly rotating shift workers. The mean (±SD) follow-up repetitions of the workers was 7.09 (±1.91), 7.69 (±1.91) and 6.71 (±1.90), respectively, in routinely rotating shift, weekly rotating shift and day workers. Table 2 shows the mean changes of BMI, SBP and DBP of the workers. The mean BMI change of the weekly rotating shift workers was significantly lower compared with the day workers and routinely rotating shift workers. The results obtained from the Bayesian multilevel modelling approach for evaluating the relationship between job schedule type and BP,

Table 1. Comparison of baseline characteristics of workers at their first periodic physical examination

Variables	Job schedule type				
	Routinely rotating shift workers ($n = 2643$)	Weekly rotating shift workers ($n = 340$)	Day worker ($n = 2348$)	Total ($n = 5331$)	*P*
Mean SBP (mmHg) (SD)	118.7 (8.1)	118.5 (7.1)	118.6 (8.2)	118.7 (8.1)	NS
Mean DBP (mmHg) (SD)	73 (6.7)	72.1 (6.2)	73.3 (6.7)	73.1 (6.7)	*
Mean BMI (kg/m^2) (SD)	24.7 (3.3)	24.5 (2.8)	24.9 (3.5)	24.8 (3.4)	NS
Mean age (years) (SD)	33.9 (6.4)	36.2 (5.4)	35.6 (6.8)	34.8 (6.6)	***
Mean work experience (years) (SD)	9.1 (5.7)	11.1 (4.7)	9.4 (6.6)	9.4 (6.1)	***
Smoking habit (smoker) *n* (%)	434 (16)	56 (16)	270 (11)	791 (14)	***
Marital status (married) *n* (%)	2391 (90)	320 (94)	2219 (94)	4930 (92)	***
Education (academic education) *n* (%)	2085 (78)	259 (76)	2196 (93)	4571 (85)	***

NS, not significant. Categorical data analysed using chi-square test. Continuous data analysed using analysis of variance.
*$P < 0.05$; ***$P < 0.001$.

Table 2. Comparison of mean changes in BP and BMI in three job schedule types

Variables	Job schedule type				
	Routinely rotating shift workers	Weekly rotating shift workers	Day worker	Total	*P*
Mean SBP change per year (mmHg) (SD)	−0.61 (2.7)	−0.68 (1.9)	−0.58 (2.7)	−0.60 (2.6)	NS
Mean DBP change per year (mmHg) (SD)	0.60 (2)	0.69 (1.6)	0.55 (2)	0.58 (2)	NS
Mean BMI change per year (kg/m^2) (SD)	0.24 (0.5)	0.17 (0.4)	0.23 (0.5)	0.23 (0.5)	*

NS, not significant. Continuous non-normal data analysed using Kruskal–Wallis test.
*$P < 0.05$.

adjusted for BMI, age, work experience, marriage, smoking and educational status are shown in Table 3. These results revealed no significant difference in mean SBP and DBP of categories of job schedule type.

Table 3. Bayesian multilevel regression results for assessing the effect of job schedule type on BP, adjusted for BMI, age, work experience, marriage, smoking and educational status

Response	Job schedule type	Estimate (SD)	*P*
SBP	Weekly rotating shift	−0.05 (0.14)	NS
	Routine rotating shift	0.16 (0.09)	NS
	Day worker	Reference category	
DBP	Weekly rotating shift	−0.20 (0.29)	NS
	Routine rotating shift	−0.18(0.19)	NS
	Day worker	Reference category	

NS, not significant.

Discussion

This study did not find an association between SW and BP in employees of MSC. However, this study has several limitations. Firstly, employee BP was unavailable prior to recruitment. Secondly, the findings might have been influenced by the healthy worker effect, with healthier individuals usually being recruited as shift workers. The major strengths of this study were the large sample size and the long follow-up period (>7 years, on average). In addition, the accuracy and reproducibility of the results were ensured by utilizing a complicated and powerful statistical modelling approach for data analysis.

A review of the published articles on the relationship between SW and BP reveals conflicting findings. A number of studies conclude that those working shifts had a significantly higher BP than day workers. For instance, Su *et al.* [19] found that working on night shifts elevated the 24 h BP. Moreover, Lo *et al.* [20] reported that BP increases during work compared with leisure time; they also noted that BP decreases during rest periods in day work employees but remains high during the rest period after evening and night shifts. Also, the findings of a meta-analysis performed on cross-sectional studies with small sample sizes are mostly in favour of elevated BP in shift workers compared with day workers [21]. A study conducted in a Japanese nuclear power plant showed that SW strongly affects BP [22]. A positive relationship between SW and BP has also been reported in different cohort studies, including a 10 year cohort of Japanese steel workers [4,23], a 5 year retrospective cohort of manual workers [5] and a 14 year historical cohort of steel workers [7]. On the other hand, other studies report no significant association between SW and BP [9–15]. This lack of association may be attributed to the healthy worker effect, with healthier individuals usually being recruited as shift workers, and less healthy workers being restricted to day work. The findings may also be due to the implementation of the 'Stop Hypertension in Mobarakeh Steel Company' (SHIMSCO) plan for controlling hypertension in MSC [24]. SHIMSCO is a workplace intervention project on controlling hypertension in industrial workers, where employees participated in an educational program comprising healthy lifestyle and self-care recommendations for hypertension management.

In general, the results obtained from the present study do not support a significant effect of SW on increased SBP and DBP. To assess the relationship between SW and BP more accurately, prospective studies adjusted for confounding factors such as occupational history, family history and psychological factors (e.g. occupational stress and job satisfaction) are required.

Key points

- This is the first historical cohort study to present data on the relationship between shift work and blood pressure among Iranian steel workers.
- The findings do not support a significant effect of shift work on blood pressure.
- The results could contribute to the development of an evidence base of Iranian steel workers' health.

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Conflicts of interest

None declared.

References

1. Costa G. Shift work and health: current problems and preventive actions. *Saf Health Work* 2010;**1:**112–123.
2. Rosa RR, Colligan MJ. *Plain Language About Shiftwork*. Cincinnati: DHHS (NIOSH) Publication, 1997.
3. Motohashi Y, Higuchi S, Maeda A *et al.* Alteration of circadian time structure of blood pressure caused by night shift schedule. *Occup Med (Lond)* 1998;**48:**523–528.
4. Oishi M, Suwazono Y, Sakata K *et al.* A longitudinal study on the relationship between shift work and the progression of hypertension in male Japanese workers. *J Hypertens* 2005;**23:**2173–2178.
5. Morikawa Y, Nakagawa H, Miura K *et al.* Relationship between shift work and onset of hypertension in a cohort of manual workers. *Scand J Work Environ Health* 1999;**25:**100–104.
6. Ghiasvand M, Heshmat R, Golpira R *et al.* Shift working and risk of lipid disorders: a cross-sectional study. *Lipids Health Dis* 2006;**5:**9.
7. Wilson P, Kannel W. Hypertension, other risk factors and the risk of cardiovascular disease. In: Laragh JH, Brenner BM, eds. *Hypertension: Pathophysiology, Diagnosis and Management*. 2nd edn. New York: Raven Press, 1995.
8. Gholami Fesharaki M, Yadegarfar GH, Sanati J. Study of factors in blood pressure in a retrospective cohort study of employees working at Polyacryl Esfahan between 1991–2008: an application of multilevel. In: *The First Seminar on Prevention, Diagnosis & Management of Hypertension, 2011*. Faculty of Health, Esfahan University of Medical Sciences, Esfahan, Iran.
9. Yadegarfar G, McNamee R. The 'healthy shift worker' effect in the relationship between shift work and longitudinal change in blood pressure [Abstract]. *Ann Epidemiol* 2003;**13:**559–596.
10. Murata K, Yano E, Hashimoto H, Karita K, Dakeishi M. Effects of shift work on QTc interval and blood pressure in relation to heart rate variability. *Int Arch Occup Environ Health* 2005;**78:**287–292.
11. Virkkunen H, Härmä M, Kauppinen T, Tenkanen L. Shift work, occupational noise and physical workload with ensuing development of blood pressure and their joint effect on the risk of coronary heart disease. *Scand J Work Environ Health* 2007;**33:**425–434.
12. Merijantia LT, Samara D, Tandean R *et al.* The role of night shift work on blood pressure among healthy female nurses. *Universa Medicina* 2008;**27:**65–71.
13. Puttonena S, Kivimäkib M, Elovainio M *et al.* Shift work in young adults and carotid artery intima–media thickness: The Cardiovascular Risk in Young Finns study. *Atherosclerosis* 2009;**205:**608–613.
14. Hublin C, Partinen M, Koskenvuo K, Silventoinen K, Koskenvuo M, Kaprio J. Shift-work and cardiovascular disease: a population-based 22-year follow-up study. *Eur J Epidemiol* 2010;**25:**315–323.
15. Sfreddo C, Fuchs SC, Merlo AR, Fuchs FD. Shift work is not associated with high blood pressure or prevalence of hypertension. *PLoS One* 2010;**5:**e15250.
16. Yamasaki F, Schwartz JE, Gerber LM, Warren K, Pickering TG. Impact of shift work and race/ethnicity on the diurnal rhythm of blood pressure and catecholamines. *Hypertension* 1998;**32:**417–423.
17. McNamee R, Binks K, Jones S, Faulkner D, Slovak A, Cherry NM. Shiftwork and mortality from ischaemic heart disease. *Occup Environ Med* 1996;**53:**367–373.
18. Congdon P. *Bayesian Statistical Modelling*. 2nd edn. England: John Wiley & Sons, 2006.
19. Su TC, Lin LY, Baker D *et al.* Elevated blood pressure, decreased heart rate variability and incomplete blood pressure recovery after a 12-hour night shift work. *J Occup Health* 2008;**50:**380–386.
20. Lo SH, Liau CS, Hwang JS, Wang JD. Dynamic blood pressure changes and recovery under different work shifts in young women. *Am J Hypertens* 2008;**21:**759–764.
21. Knutsson A, Bøggild H. Shiftwork and cardiovascular disease: review of disease mechanisms. *Rev Environ Health* 2000;**15:**359–372.
22. Ohira T, Tanigawa T, Iso H *et al.* Effects of shift work on 24-hour ambulatory blood pressure and its variability among Japanese workers. *Scand J Work Environ Health* 2000;**26:**421–426.
23. Sakata K, Suwazono Y, Harada H, Okubo Y, Kobayashi E, Nogawa K. The relationship between shift work and the onset of hypertension in male Japanese workers. *J Occup Environ Med* 2003;**45:**1002–1006.
24. Khosravi AR, Rowzati M, Gharipour M *et al.* Hypertension control in industrial employees: findings from SHIMSCO study. *ARYA Atheroscler* 2012;**7:**191–196.