

Association between glycemc control and shift working among healthcare workers with diabetes, Dammam, Saudi Arabia

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ABSTRACT

الأهداف: إيضاح العلاقة بين العمل بنظام الورديات والتحكم في نسبة السكر بالدم بين العاملين في مجال الرعاية الصحية المصابين بداء السكري في مستشفيات مدينة الدمام بالمملكة العربية السعودية.

المنهجية: أجريت دراسة مسحية بين العاملين في مجال الرعاية الصحية المصابين بالسكري في ثلاثة مستشفيات بالدمام من نوفمبر 2018م إلى يناير 2019م. أجاب المشاركون في الدراسة على استبيان ذاتي يتعلق بالبيانات الديموغرافية وأسئلة متعلقة بالعمل وأخرى متعلقة بمرض السكري ونشاطات التحكم الذاتية. استخدمنا الانحدار اللوجستي متعدد المتغيرات لتحديد العلاقة بين عامل الخطر للتحكم في نسبة السكر بالدم والعمل بنظام الورديات.

النتائج: تراوحت أعمار المشاركين بين 24 و 60 عاماً. كان متوسط عمراالعاملين بنظام العمل النهاري والعاملين بنظام المناوبات 42.4 ± 7.7 عام و 42.1 ± 7.3 عام على التوالي. لوحظ فرق كبير بين العاملين بنظام العمل النهاري والعاملين بنظام المناوبات من حيث المهنة والسمنة. أفاد موظفوا العمل النهاري أنهم أكثر نشاطاً بدنياً مقارنة بعمال المناوبات. كما كان الموظف العامل بنظام العمل النهاري أكثر توفيتاً للزيارات الروتينية لعيادة السكري. كان لدى عمال المناوبات زيادة في الوزن بسبب تناول الطعام غير الصحي، وقلة النوم والنشاط البدني غير السليم مقارنة بالموظفين العاملين بنظام العمل النهاري. أظهر التناوب عكس اتجاه عقارب الساعة أن 92.9% من الموظفين تطور لديهم داء السكري غير المنضبط.

الخلاصة: خلصت هذه الدراسة المقطعية إلى أن التحكم في نسبة السكر في الدم قد ساء بين العاملين المصابين بداء السكري والعاملين بنظام المناوبات مقارنة بأقرانهم العاملين بنظام العمل النهاري.

Objectives: To delineate the relation between shift work and glycemc control among the healthcare workers (HCWs) with diabetes mellitus (DM) in the hospitals of Dammam, Saudi Arabia.

Methods: Across-sectional study was conducted among HCWs with DM working in 3 hospitals in Dammam, Saudi Arabia, from November 2018 to January 2019. The study participants answered a self-administered questionnaire related to sociodemographic data, work-related questions, diabetes-related questions, the latest hemoglobin A1C test outcome, and self-management activities. The Chi-square and t-test were used to determine the association between the risk factor of glycemc control and shift work.

Results: The HCW's ages ranged from 24-60 years. The mean age of the employees in the day shift was 42.4 ± 7.7 years and night shift was 42.1 ± 7.3 years. The significant difference between daytime workers and shift workers was observed in terms of occupation, and obesity. Day shift employees reported being significantly more physically active than shift workers. The daily day shift led the employee to miss their routine clinic visits for DM. Shift workers had more weight gain due to unhealthy food intake, sleep deprivation, and improper physical activity when compared with daytime employees. Anti-clockwise shift rotation significantly demonstrated that 92.9% of employees developed uncontrolled DM.

Conclusion: Glycemc control was worsened among the shift worker with DM compared to daytime workers.

Keywords: shift work schedule, sleep disorders, glycemc control, diabetes mellitus, health personnel

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Although no standard definition of “shift work” is available, shift work term is usually used to describe the work scheduled outside the standard working hours.¹ The working shift is essential and inevitable in many sectors willing to provide 24-hour continuous services.² It is estimated that the prevalence of shift work has increased approximately 27% in the United States in recent years.³ Previous studies reported an association between shift work and chronic illnesses like diabetes mellitus (DM), cardiovascular diseases (CVDs), obesity, and cancer.^{4,5} However, this association was also linked to other factors like lifestyle changes, social stress, job changes, and circadian rhythm impairment.^{6,7}

Diabetes mellitus is a significant public health-related problem. The World Health Organization (WHO) stated that more than 400 million individuals are living with DM worldwide with approximately 1.6 million recorded deaths every year.^{8,9}

The prevalence of DM in Saudi Arabia is rapidly increasing at an alarming rate over the past few years. It has affected approximately 20% of the adult population. The prevalence rate is expected to increase further and exceed more than 40% of the adult population by 2030.^{10,11}

Diabetes mellitus is a metabolic disorder that causes a rise in blood glucose levels. The risk factors of DM are obesity, increasing age, family history, smoking, and physical inactivity. These risk factors reported emerging evidence about the relationship between circadian misalignment and glucose intolerance.¹² The literature suggests that shift work is associated with several health-related issues including diabetes. One study reported that midnight workers devour higher calories food when compared with fixed day employees.¹³ Similarly, another researcher reported an association between shift work and the development of abdominal obesity.¹⁴ The incidence of DM is higher among shift workers due to sleep deprivation, a recognized risk factor for diabetes.¹⁵ A cross-sectional study of 95 patients with type-2 DM working in one of the Brazilian hospitals was divided into 2 groups, namely, day and night shifts. This study suggested insulin resistance is responsible of causing larger waist circumference among the workers on the night shift.¹⁶

Similarly, another cross-sectional study of 27,485 employers in Sweden stated lower high-density lipoprotein (HDL) cholesterol concentration, high triglyceride level, and increased obesity among the night shift workers than day shift workers. This study suggested a potential association between shift work and DM.¹⁷ Also, the outcome of a recent study signifies the negative impact on postprandial triglyceride responses

and insulin sensitivity after the rotational period of night shift.¹⁸

This cross-sectional study aims to observe and outline the association between shift work and DM among HCWs in Dammam hospitals of Saudi Arabia. This study compares day shift and night shift effects on diabetic control by assessing hemoglobin A1C (HbA1c), sleep, physical activities, and diet.

Methods. A cross sectional study was carried out among diabetic healthcare workers (namely: doctors, nurses, pharmacists, technicians, and administrators). These employees were diagnosed at their employee health clinics. The study was carried of from November 2018 to January 2019 at 3 hospitals in Dammam, Saudi Arabia (Dammam Medical Complex [DMC], Maternity and Children Hospital [MCH], and Alamal Hospital). The total number of HCWs in these hospitals was 6700 (DMC: 3,100, MCH: 2,600, and Alamal Hospital: 1,000). The sample size was calculated to be 365 using Epi Info™ at 95% confidence level, 50% expected frequency, and 4.5% acceptable margin of error.¹⁹ The study was performed in these 3 hospitals to make the findings more generalize as each hospital provides a different medical service from the others. This study involves volunteers participation and is ready to provide 100% response until the study ends.

The inclusion criteria were HCWs with DM, male or female, working either in irregularly alternating shifts or exclusively in morning shifts who have had recently performed HbA1c test in the preceding 3 months. Healthcare workers who were diagnosed with DM in less than one year and those working less than 3 night shifts per month were excluded.

The HbA1c level of participants was grouped as controlled (HbA1c level <7%) and uncontrolled (HbA1c level ≥7%). Also, the participants were categorized into 3 groups: fixed day shift employees (working hours: 07:00-15:00 hours), evening shift employees (working hours: 15:00-23:00 hours), and night shift employees (working hours: 23:00-07:00 hours) based on their latest 3-month working shifts. The study includes HCWs with clockwise or counterclockwise rotation of shift work. Participants were selected by the convenience sampling technique and the analysis was not started until achieving the required sample size target of 365. The study participants answered a self-administered questionnaire related to sociodemographic data (4 items), work-related questions (4 items), diabetes-related questions, latest HbA1c test outcome and self-management activities includes being physically active, bringing healthy food to the workplace, and keeping

regular DM clinic follow-up visits (6 items). The questionnaire is validated by consulting 3 consultants specialized in occupational health. To further test the questionnaire validity, a pilot study was conducted on 10 HCWs with DM, who were excluded later from the study sample. The clarity of some questionnaire items needed for modifications were completed in light of the pilot study results.

Assessments of physical activity and healthy diet in this study are based on the definitions and recommendations of WHO. The World Health Organization recommends that adults should undertake physical activity and should aim to achieve at least 150 minutes of moderate-intensity or equivalent per week.²⁰ Daily healthy diet is defined, based on the WHO recommendations, as consuming more than 400 grams of vegetables and fruits, <30% fat intake of total energy intake, and <10% free sugar of total energy intake and consuming <5 grams of salt per day.²¹ While good quality sleep is defined as person's perception of falling asleep easily after getting into bed with sufficient sleep duration (not less than 7 hours) along without complaints of sleepiness during the day.²²

The Department of Research and Studies at the General Health Affairs at the Eastern Region, Saudi Ministry of Health, Saudi Arabia, gave the ethical clearance to conduct this study. All participants were assured confidentiality and provided informed consent for participation in this study.

Statistical analysis. Demographic, occupational, and lifestyle characteristics distribution were compared with employees of day shift and night shift at 95% confidence level and 5% significance level by using descriptive and inferential statistics. Descriptive statistics was used for continuous outcome variables. Analysis was carried out to determine the variables that are independently and significantly correlated to the HbA1c. Chi-square and t-test were used to assess the factors associated with DM for categorical variables and numeric data. Multivariate analysis was performed using logistic regression with diabetic control as the dependent variable and independent factors. Data was analyzed by using Statistical Package for the Social Sciences for Windows, version 25.0 (IBM Corp., Armonk, NY, USA).

Results. Baseline characteristics of this cross-sectional study are reported in **Table 1**. The participant's ages ranged from 24-60 years. The mean age of the employees in the day shift was 42.4±7.7 years and night shifts was 42.1±7.3 years. The study population consisted of 53.2% of male and 46.8% female workers. Similarly, the study enrolled 45.4% nurses,

16.5% technicians, and 8.1% physicians. Most of the employees were married (65.7%), followed by single (21.1%), and divorced (13.2%). Most of the employees worked as shift workers (59.7%), followed by day shift employees (40.3%). Less than a quarter of employees had counterclockwise rotation (12.7%), while the rest had clockwise shift work (87.3%).

An independent student t-test and Chi-square tests were conducted to compare daytime workers and shift workers' age, gender, occupation, and marital status. The analysis reported a significant difference between daytime workers and shift workers in terms of occupation. Also, the study demonstrated no significant association of age, gender, and marital status between daytime workers and shift workers. Most of the employees were obese (91.0%), body mass index (BMI) of more than 25 kg/m². Chi-square test compared diabetes-related questions (namely, BMI, smoking status, and latest HbA1c) between daytime and shift workers. This study significantly observed higher BMI among shift workers than day workers. There was no significant difference between daytime workers and shift workers in smoking ($\chi^2=1.97$; $p=0.162$).

Most of the participants (42.4%) reported moderate exercise for <150 minutes per week, followed by 42.4% of participants with no exercise, and 26.2% of participants reported extreme exercise for >150 minutes per week. Only 29.7% of employees reported routine visits of DM clinic, 48.3% of employees reported occasional routine visits while 21.8% employees were completely missing their follow-up visits. Day shift employees reported being more physically active than shift workers, and the outcome was statistically significant ($p<0.05$). Also, day workers significantly missed their routine visits for DM clinics compared with shift workers. The Chi-square test compared the quality and duration of sleep, and dietary food among day and shift workers. The analysis significantly reported that frequency and quality of lousy sleep were higher among shift workers by 49.8% than daytime workers. Similarly, the analysis reported frequency of healthy dietary foods was significantly higher by 52.3% among daytime workers than shift workers.

The mean age of the employees in the controlled group was 42.7±7.2 years and uncontrolled group was 41.7±7.6 years. The Chi-square analysis demonstrated significant uncontrolled HbA1c in 60.6% of employees on shift work and 30.2% of employees in the daytime. In addition to this, anti-clockwise shift rotation significantly demonstrated that 92.9% of employees develop uncontrolled HbA1c. Moreover, employees with normal BMI significantly demonstrated 81.8%

Table 1 - Descriptive statistics for respondents' work type and glycemic control according to sociodemographic, diabetes related questions, self-management activities, sleep and diet.

Characteristics	Shift work (n=221)	Daytime work (n=149)	Total	Test of sig.	P-value	HbA1c %		Test of sig.	P-value
						Controlled	Uncontrolled		
			n (%)				n (%)		
Age, mean±SD	42.1±7.3	42.4±7.7		t-test= 0.406	0.685	42.7±7.2	41.7±7.6	t-test= 1.3	0.190
Gender									
Male	114 (51.6)	83 (55.7)	197 (53.2)	x ² = 0.607	0.436	100 (50.8)	97 (49.2)	x ² =0.125	0.724
Female	107 (48.4)	66 (44.3)	173 (46.8)			91 (52.6)	82 (47.4)		
Occupation									
Doctor	19 (8.6)	11 (7.4)	30 (8.1)	x ² = 47.58	0.001	17 (56.7)	13 (43.3)	x ² = 4.99	0.172
Nurse	124 (56.1)	44 (29.5)	168 (45.4)			78 (46.4)	90 (53.6)		
Technician	41 (18.6)	20 (13.4)	61 (16.4)			30 (49.2)	31 (50.8)		
Other	37 (16.7)	74 (49.7)	111 (30)			66 (59.5)	45 (40.5)		
Marital status									
Single	53 (24)	25 (16.9)	78 (21.1)	x ² = 2.779	0.249	32 (41)	46 (59)	x ² = 5.149	0.076
Married	140 (63.3)	103 (69.1)	243 (65.7)			135 (55.6)	108 (44.4)		
Other	28 (12.7)	21 (14.1)	49 (13.2)			42 (49)	25 (51)		
BMI category									
18-24.99	17 (7.7)	16 (10.7)	33 (8.9)	x ² = 8.29	0.016	27 (81.8)	6 (18.2)	x ² = 27.9	0.001
25-29.99	111 (50.2)	92 (60.7)	203 (54.8)			116 (57.1)	87 (42.9)		
>30	93 (42.1)	41 (27.5)	134 (36.2)			48 (35.8)	86 (64.2)		
Smoking									
Yes	63 (28.7)	52 (34.9)	115 (31.1)	x ² = 1.97	0.162	57 (50)	57 (50)	x ² = 0.173	0.677
No	158 (71.3)	97 (65.1)	255 (68.9)			134 (52.3)	122 (47.7)		
Physical activity per week									
>150 min	42 (19)	55(36.9)	97 (26.2)	x ² = 16.27	0.001	69 (71.1)	28 (28.9)	x ² = 24.7	0.001
<150 min	98 (44.3)	59 (39.6)	157 (42.4)			79 (50.3)	78 (49.7)		
None	81 (36.7)	35 (23.5)	116 (31.3)			43 (37.1)	73 (62.9)		
Missing regular routine visits in diabetes clinic									
Yes	62 (28.1)	19 (12.8)	81 (21.8)	x ² = 16.6	0.001	32 (39.5)	49 (60.5)	x ² = 12.55	0.002
No	52 (23.5)	58 (38.9)	110 (29.7)			71 (64.5)	39 (35.5)		
Sometimes	107 (48.4)	72 (48.3)	179 (48.3)			88 (49.2)	91 (50.8)		
Night sleeping hours									
<7 hours	166 (75.1)	94 (63.1)	260 (70.2)	x ² = 25.22	0.001	125 (48.1)	135 (51.9)	x ² = 6.05	0.049
7-9 hours	30 (13.6)	50 (33.6)	80 (21.6)			51 (63.8)	29 (36.2)		
>9 hours	25 (11.3)	5 (3.4)	30 (8.1)			15 (50)	15 (50)		
Sleep quality									
Good	111 (50.2)	104 (69.8)	215 (58.1)	x ² = 14.25	0.001	136 (63.3)	79 (36.7)	x ² = 27.8	0.001
Bad	110 (49.8)	45 (30.2)	155 (41.8)			55 (35.5)	100 (64.5)		
Diet									
Healthy	50 (22.6)	78 (52.3)	128 (34.5)	x ² = 37.15	0.001	108 (84.4)	20 (15.6)	x ² = 112.5	0.001
Less healthy	114 (51.6)	55 (36.9)	169 (45.6)			77 (45.6)	92 (54.5)		
Unhealthy	57 (25.8)	16 (10.7)	73 (19.7)			6 (8.2)	67 (91.6)		

sig: significant, HbA1c: hemoglobin A1C, SD: standard deviation, BMI: body mass index, min: minutes

of controlled and 18.2% of uncontrolled HbA1c levels. The obese employee reported a high degree of uncontrolled HbA1c level ($x^2=27.9$; $p=0.001$).

Improper physical activity, missing regular follow-up, and low duration and lousy sleep quality were significantly higher among the uncontrolled group than the control group. This study reported that Alamal Hospital staff had significantly more controlled HbA1c followed by DMC and MCH. Similarly, MCH staff had

significantly more uncontrolled HbA1c than DMC and Alamal Hospital. The effect of the nature of diet had a linkage with diabetic control. Most of the participants having healthy diets (84.4%) had controlled diabetes. Similarly, the majority of participants with unhealthy diets (91.6%) had uncontrolled diabetes. Other factors like age, gender, marital status, occupation, and smoking history had no significant association with the control of diabetes, as shown in **Table 1**.

Multiple regression analyzed the effects of factors like work type (day/shift), occupation, hospital, BMI, physical activity, regular follow up visits, and sleep quality and duration on diabetic control. However, few factors like work type, hospital, dietary food, and BMI of the employees significantly affected diabetic control as described in **Table 2**. According to this study, a good diabetic control method was associated with routine daywork, a healthy diet, and an average BMI. Moreover, working in Alamal Hospital was associated with well-controlled DM.

Discussion. This study observed that shift work (39.4%) was significantly associated with worse diabetic control among employees with DM than daytime work (60.6%). These findings had a similar agreement with a study evaluating insulin resistance, reporting that shift workers had developed insulin resistance more frequently than daytime workers.²³

Logistic regression suggested that obesity and unhealthy dietary foods had a negative effect on glycemic control. Similarly, it demonstrated that shift work has a negative influence on diabetes control. For patients with DM, such work schedule requires adjusting mealtimes and insulin dosing schedule without triggering hypoglycemia episodes, which may account for their worse glycemic control.⁵

Our study reported that obesity rates in shift workers was 92.03% and daytime worker was 27.5%. These findings agreed with a survey conducted by El Tayeb et al,¹ who reported that the shift work group had significantly higher BMI when compared to the daytime work group. The shift work increases weight gain and the rising prevalence of DM. Shift work differs with food availability during routine daytime work,

resulting in eating snacks, high-fat food, and weight gain.⁵

Also, shift work negatively affects the nutritional need of the body. Our study demonstrated that 77.4% of HCWs have uncontrolled DM due to unhealthy food. This finding was in accordance with a cross-sectional study where the night shift workers had the highest calorie intake.¹³ Similarly, Manodpitipong et al,²⁴ revealed that night shift employees had considerably greater daily calorie consumption than other groups, which might lead to a higher BMI in a long term.

Our findings suggest that the shift worker was significantly less physically active than the daytime worker. Another study conducted in Poland in 2014 revealed that rotating night shift nurses and midwives had considerably lower exercise levels than those working solely during the day.²⁵ Exercise improves glucose regulation by improving insulin sensitivity and non-insulin-dependent glucose uptake in skeletal muscle.²⁶

Alamal Hospital, a psychiatric hospital, had the best controlled DM workers, which might be reflecting low work stress level, optimal workers to patient's ratio, flexible working schedule, and the presence of DM specialists in the hospital employee clinic.

Study limitations. The recall bias of the last 3 months of HbA1c reading, subjective assessment of sleep, nature of the sampling technique used, and unavailability of data on nationality (Saudi and non-Saudi). In addition, the study was carried out in one city in the country, and may not be fully generalizable to other places. Despite these limitations, the study provides an important evaluation of multiple factors (HbA1c, sleep, diet, and self-management activity) in HCWs with DM in the day and shift work.

Table 2 - Multiple regression analysis of variables controlling diabetes.

Variables	B	S.E.	Wald	Df	Sig.	Adj OR	95% CI for adj OR	
							Lower	Upper
Working in shifts	3.131	0.571	30.032	1	>0.001	22.888	7.471	70.126
Psychiatry (ref)			49.967	2	>0.001			
DMC	3.776	0.635	35.327	1	>0.001	43.645	12.565	151.606
MCH	2.692	0.430	39.154	1	>0.001	14.760	6.352	34.300
Healthy diet (ref)			48.079	2	>0.001			
Less healthy diet	1.849	0.354	27.251	1	>0.001	6.353	3.173	12.719
Unhealthy diet	3.783	0.578	42.828	1	>0.001	43.953	14.156	136.475
BMI	0.122	0.051	5.774	1	0.016	1.130	1.023	1.248
Constant	-8.324	1.827	20.760	1	>0.001	0.000		

B: coefficient, S.E: standard error, Wald: Wald test, Df: degrees of freedom, Ref: reference, Sig: significant, Adj: adjust, OR: odd ratio, CI: confidence interval, DMC: Dammam Medical Complex, MCH: Maternity and Children Hospital, BMI: body mass index

In conclusion, glycemic control was worsened among the shift workers with DM compared to daytime workers. Shift work was linked with shorter and lousy sleep patterns, reduced physical activity, and decreased adherence to self-management activities. In addition, the study revealed that the anti-clockwise shifting schedule had the worst impact on controlling DM. Healthcare institutions should have a mechanism to identify staff with DM working in irregularly alternating shifts along with adaptation programs including availability of DM specialists in the hospital employee clinic.

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