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The Relationship between Dietary Intake, Obesity and Shift Working on Employees of Pasargad Petrochemical Company in Asaluyeh, Iran

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ABSTRACT

Background: Shift work in services and industry is increasing in developing countries, especially industrialized ones, due to the need for a flexible workforce and to achieve maximum efficiency. Shift working can cause problems for people's health and bodily functions. This study aims to determine the relationship between dietary intake, obesity, and shift working among employees of Pasargad Petrochemical Company. **Methods:** This was a cross-sectional study conducted on 119 employees within the age range of 25-60 years and an average body mass index (BMI) of 25.67. Their food intakes were extracted using Food Frequency Questionnaires. Data analysis was performed through STATA data analysis software. **Results:** 119 male participants with a mean age of 33.62 ±7.12 year were included in the study, of whom 64.7% were non-shift workers and 35.3% were shift workers. The daily calorie intake of the participants was 2864.54 ± 1184.43 kcal. Although non-shift workers consumed a higher but insignificant amount of energy, no statistical differences were found in dietary intake between shift workers and non-shift workers ($P<0.05$). Furthermore, multiple linear regressions regarding shift work did not have a significant effect on BMI and waist circumference. **Conclusion:** Although no statistically significant relationship was found between food intake and shift work, it is suggested that future studies be conducted with a larger sample size because of the importance of shift work.

Keywords: *Shift work schedule; Diet; Body mass index; Obesity; Dietary intake;*

Introduction

Shift work, as work done outside normal working hours during the day, is increasing in developing and industrialized countries, that results in more than 20% of the employed population being shift workers (Gordon *et al.*, 1986). Moreover, it is closely linked to metabolic disorders such as diabetes and cardiovascular disease. Many factors affecting shift workers including circadian rhythms and eating habits are risk factors for health (Kervezee *et al.*, 2020).

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Studies have indicated that the risk of cardiovascular disease may increase with shift-working (Lunde *et al.*, 2020).

Obesity is also known to be one of the most important causes of coronary heart disease (Björntorp, 1998, Diba *et al.*, 2018, Mehri and Babri, 2021, Mehri *et al.*, 2019, Oskuye *et al.*, 2019, Valenzuela *et al.*, 2023), which is significantly more common among shift-workers (Orth-Gomer, 1983, Romon *et al.*, 1992).

The circadian rhythm disorders in shift workers can lead to poor eating habits. Inadequate eating patterns in the long run, along with other unhealthy habits such as insufficient sleep and increased stress levels, expose these people to overweight and various diseases, including cardiovascular disease (Ghanbary Sartang *et al.*, 2016). Shift workers tend to eat at the wrong time; this can increase circadian rhythm disorders as well. (Rogers *et al.*, 2004) The results of a study demonstrated that 20-75% of shift workers suffer from digestive problems such as heartburn, abdominal pain, constipation, indigestion, and bloating (Costa, 1996). Eating fast, the tendency to eat fast food, and consuming high amounts of caffeine are other eating habits formed among shift workers. The formation of improper eating habits over time impacts appetite cycles, hunger, satiety, and metabolism. Following the formation of poor eating habits, food intake including micro and macro-nutrients, can be affected (Lowden *et al.*, 2010).

Few studies have been conducted to assess and diagnose physiological problems in shift workers, especially in Iran (Choobineh *et al.*, 2018, Hoboubi *et al.*, 2017). Since many of these problems are related to biochemical disorders, the role of nutrition in these workers is very important. Therefore, this study is designed to investigate the relationship between nutritional intake, obesity, and shift working among employees of Pasargad Petrochemical Company.

Materials and Methods

Design and participants: This was a cross-sectional observational study. The protocol of study was approved by the ethics committee of Bushehr University of Medical Sciences. The sample consisted of non-shift workers and shift workers of Pasargad Petrochemical Company, Assaluyeh, Iran. One hundred thirty four non-shift workers and shift workers aged 25-50 years were selected. Inclusion criteria were: 1- Being an employee of Pasargad Petrochemical Company, 2- Being a male in the age range of 25 - 50, 3- Having the willingness to participate in the study, 4- Having at least one year of work experience. Exclusion criteria were: 1- Unwillingness to cooperate, 2- Having chronic diseases (diabetes, cancer, cardiovascular, etc.)

The employees were divided into two groups i.e. non-shit work and shift work. In the next step, the study was informed to all petrochemical employees with distribution of posters. They were visited during their work shifts and eligible employees were included in the study.

Measurements: Two researchers filled the questionnaires. The questionnaires included different kinds of information. The first questionnaire asked about demographic characteristics completed through interviews. This questionnaire recorded age; marital status; education; work status (shift worker or non-shift worker); diet; and having a family history of obesity, diabetes, hyperlipidemia, cancer, high blood pressure, heart attack, and stroke. Another one was a 3-day 24-hour food recall questionnaire, which was completed by a trained nutritionist through interviews with employees. The third questionnaire completed was a 168-item food frequency questionnaire (FFQ). Foods were recorded based on household scales. For this purpose, food items were converted to grams per day and analyzed by the Nutritionist IV software to estimate daily energy intake, and macro- and micro-nutrients.

Weight was measured using Seca scale (Germany) with an accuracy of 100 grams. A Seca satdiometer (Germany) was used to measure height with an accuracy of 0.5 cm, where participants had no shoes or hat, and stood straight. Waist circumference (WC) and hip circumference (HC)

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measurements were taken using a non-elastic tape measure with an accuracy of 0.1 cm. Body mass index (BMI) was calculated by dividing weight (kg) by square of the height (m).

Ethical considerations: The study protocol was approved by the Board of Ethics of Bushehr University of Medical Sciences (Ir.bpums. rec.1395.26).

Data analysis: Data analysis was done using STATA software version 14. Categorical and continuous variables were summarized using number (%) and mean ± standard deviation, respectively. The Kolmogorov-Smirnov test was used to determine distribution of data. Chi-square and independent-sample *t-tests* were used to determine if any significant differences exist between observed and expected values in categorical and continuous data respectively. To determine the variables affecting WC and BMI, a simple linear regression was used. Variables with a significance level of less than 0.2 were entered into the multiple linear models. The coefficient and 95% confidence interval of the coefficient was reported for the effect size. The significance level was considered less than 0.05.

Results

From the 119 males with a mean age of 33.62±7.12 year, 64.7% were non-shift workers and 35.3% were shift workers. Non-shift and shift workers were not significantly different in terms of anthropometric indices. **Table 1** shows the demographic and anthropometric characteristics of employees.

Table 2 shows the participants' food intake. The daily calorie intake of the participants was 2864.54 ± 1184.43 kcal. It should be noted that there was no statistical difference between non-shift and shift workers despite receiving a higher but insignificant amount of calorie intake by non-shift workers (*P* = 0.50).

Tables 3 demonstrate the effect of shift work as well as the adjusted effect of other independent variables including age, energy, carbohydrates, protein, fat, and dietary fiber intake on BMI and WC, respectively. Although multiple linear regressions regarding shift work did not have a significant effect on BMI (0.952) and WC (0.357), each year through aging, BMI increases to 0.138 kg/m^2 (*P* = 0.009, 95% CI: 0.035, 0.240 kg/m^2), and WC increases to 0.402 cm (*P* = 0.001, 95% CI: 0.171, 0.632 cm).

Table 1. Demographic and anthropometric characteristics of the studied population based on job status.

Variables	Total population (N= 119)	Non-shift workers (N = 77)	Shift-workers (N = 42)	P-value
Age (year)	33.62 ± 7.12[a]	33.38 ± 7.39	34.07 ± 6.67	0.61[c]
Weight (Kg)	78.16 ± 12.90	77.59 ± 13.86	79.21 ± 10.99	0.51[c]
Height (cm)	174.46 ± 5.97	173.89 ± 5.75	175.50 ± 6.28	0.16[c]
BMI (kg/m^2)	25.67 ± 4.01	25.63 ± 4.23	25.75 ± 3.62	0.87[c]
WC (cm)	91.59 ± 9.32	92.06 ± 9.80	90.71 ± 8.42	0.45[c]
HC (cm)	100.55 ± 7.45	100.88 ± 7.75	99.93 ± 6.92	0.50[c]
WHR	0.91 ± 0.04	0.91 ± 0.05	0.90 ± 0.05	0.67[c]
WHtR	0.52 ± 0.05	0.52 ± 0.05	0.51 ± 0.05	0.24[c]
Weight status				0.20[d]
Normal	56 (47.1)[b]	39 (50.6)	17 (40.5)	
Overweight	47 (39.5)	26 (33.8)	21 (50.0)	
Obese	16 (13.4)	12 (15.6)	4 (9.5)	
WHR status				1[d]
Normal	51 (42.9)	33 (42.9)	18 (42.9)	
High	68 (57.1)	44 (57.1)	24 (57.1)	
WHtR status				0.25[d]
Normal	61 (51.3)	36 (46.8)	25 (59.5)	
High	58 (48.7)	41 (53.2)	17 (40.5)	

[a]: Mean ± SD, [b]: N (%), [c]: Independent sample *t-test*, [d]: Chi-square *test*, BMI: Body Mass Index; WC: Waist Circumference; HC: Hip Circumference; WHR: Waist to Hip Ratio; WHtR: Waist to Height Ratio

Table 2. Dietary intake of the studied population based on job status.

Dietary items	Total population(N=119)	Non-shift workers (N=77)	Shift-workers (N=42)	P-value [b]
Energy (kcal)	2894.76 ± 1159.15[a]	2942.09 ± 1279.58	2807.97 ± 905.57	0.54
Carbohydrate (g)	432.78 ± 184.37	438.84 ± 200.59	421.67 ± 151.83	0.62
Protein (g)	104.24 ± 37.61	105.01 ± 40.18	102.82 ± 32.78	0.76
Fat (g)	82.96 ± 41.73	85.18 ± 46.38	78.88 ± 31.60	0.43
Carbohydrate (%)	59.70 ± 7.11	59.66 ± 7.21	59.77 ± 7.01	0.93
Protein (%)	14.86 ± 3.35	14.84 ± 3.64	14.89 ± 2.79	0.93
Fat (%)	25.43 ± 5.67	25.49 ± 5.65	25.32 ± 5.79	0.87
SFA (g/d)	21.15 ± 13.00	21.93 ± 15.26	19.72 ± 7.17	0.37
MUFA (g/d)	22.49 ± 13.12	23.06 ± 14.73	21.44 ± 9.57	0.52
PUFA (g/d)	18.07 ± 10.75	17.87 ± 11.80	18.42 ± 8.61	0.79
Cholesterol (mg/d)	363.26 ± 230.67	380.09 ± 265.29	332.39 ± 145.52	0.28
Fiber (g/d)	33.09 ± 14.90	33.22 ± 14.79	32.85 ± 15.29	0.90
Sodium (mg/d)	3018.67 ± 2103.51	3081.53 ± 2386.95	2903.42 ± 1467.10	0.66
Potassium (mg/d)	5394.75 ± 2348.41	5476.94 ± 2494.49	5244.07 ± 2074.19	0.60
Magnesium (mg/d)	413.69 ± 182.22	420.31 ± 182.97	401.55 ± 182.42	0.59
Zinc (mg/d)	11.54 ± 4.62	11.68 ± 4.74	11.29 ± 4.45	0.66
Iron (mg/d)	20.14 ± 8.53	20.23 ± 8.84	19.97 ± 8.04	0.87
Calcium (mg/d)	1394.61 ± 670.72	1431.12 ± 703.78	1327.69 ± 607.86	0.42
Phosphorus (mg/d)	1734.48 ± 869.34	1763.40 ± 959.97	1681.48 ± 680.02	0.62
Copper (mg/d)	2.06 ± 1.00	2.10 ± 0.99	1.99 ± 1.01	0.57
Vitamin A (μg/d)	1722.95 ± 1036.70	1843.18 ± 1169.25	1502.53 ± 692.06	0.08
Vitamin E (mg/d)	5.04 ± 2.69	5.00 ± 2.75	5.12 ± 2.60	0.81
Vitamin K (mg/d)	170.51 ± 106.21	168.42 ± 107.56	174.34 ± 104.88	0.77
Vitamin C (mg/d)	402.59 ± 244.01	418.28 ± 279.36	373.82 ± 159.36	0.34
Vitamin B1 (mg/d)	2.14 ± 0.89	2.16 ± 1.00	2.10 ± 0.66	0.71
Vitamin B2 (mg/d)	2.57 ± 1.17	2.61 ± 1.28	2.50 ± 0.94	0.64
Vitamin B3 (mg/d)	25.71 ± 10.17	25.17 ± 10.80	26.71 ± 8.95	0.43
Vitamin B5 (mg/d)	8.08 ± 3.56	8.05 ± 3.67	8.15 ± 3.38	0.87
Vitamin B6 (mg/d)	2.72 ± 1.11	2.72 ± 1.14	2.72 ± 1.05	0.96
Vitamin B9 (mg/d)	453.40 ± 202.39	450.10 ± 193.72	459.44 ± 219.71	0.81
Vitamin B12 (μg/d)	4.18 ± 2.03	4.26 ± 2.14	4.05 ± 1.84	0.58
Biotin (mg/d)	30.77 ± 16.63	29.78 ± 15.17	32.59 ± 19.08	0.38

[a]: Mean ± SD, [b]: N (%), b: Independent sample *t-test*, SFA: Saturated Fatty Acids; MUFA: Mono-Unsaturated Fatty Acids; PUFA: Poly-Unsaturated Fatty Acids.

Table 3. Multiple regression analysis showing adjusted coefficient and statistical significance for body mass index and waist circumference.

	Body mass index				Waist circumference			
	Coefficient	P-value	95 % CI of β		Coefficient	P-value	95 % CI of β	
			Lower	Upper			Lower	Upper
Job Status	0.046	0.952	- 1.467	1.559	- 1.532	0.375	- 4.940	1.876
Age	0.138	**0.009**	0.035	0.240	0.402	0.001	0.171	0.632
Energy	0.001	0.336	- 0.001	0.002	0.002	0.089	- 0.001	0.005
Carbohydrate	0.002	0.577	- 0.001	0.011	0.001	0.846	- 0.017	0.021
Protein	- 0.003	0.839	- 0.040	0.032	- 0.015	0.715	- 0.097	0.067
Fat	- 0.018	0.251	- 0.049	0.013	- 0.046	0.196	- 0.117	0.024
Dietary Fiber	- 0.014	0.729	- 0.098	0.068	- 0.071	0.454	- 0.259	0.116

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Discussion

The results of the present study indicated that there was no statistically significant difference between non-shift workers and shift workers regarding anthropometric indices and dietary food intake. Nowadays, in the service and industry sectors, to achieve maximum productivity and a flexible workforce, employees' employment status may alternate between day and night shifts. On the other hand, shift work can cause problems for employees' health and their biological order (Gordon *et al.*, 1986).

In the present study, shift and non-shift workers were not significantly different in terms of anthropometric figures. It should be noted that BMI was higher in shift workers; however, there was no significant difference. The results of a cohort study showed that shift work could be considered a risk factor for being overweight (Morikawa *et al.*, 2007).

Based on the results, dietary intake was higher in non-shift workers compared with shift workers; but, this difference was not statistically significant. The highest amount of carbohydrate intake and the lowest amount of fiber, iron, zinc, calcium, and phosphorus intake belonged to shift workers. Studies reported that shift workers consumed more starchy foods, alcohol and sweets, which can increase their digestive problems (Zhao and Turner, 2008). Moreover, the eating habits and food choices of these workers have changed (De Assis *et al.*, 2003, Tepas, 1990). Long working hours and lack of breaks between work, unhealthy food choices, and lack of physical activity are all the causes of poor eating habits (Ragland *et al.*, 1998). In another study on 455 shift-work nurses, there was a significant negative relationship between dietary patterns and health outcomes of shift work ($r = 0.183$, $P < 0.005$) (Rahimi Pordanjani *et al.*, 2018). Differences in sample size, gender, and the study group can be the reasons for the difference in the results.

Previous studies revealed that obesity, as a risk factor for cardiovascular disease, was considerably more common among shift workers (Karlsson *et al.*, 2001, Van Amelsvoort *et al.*, 1999). Similarly, overweight has been reported to be even higher in these individuals.The working environment, an effective factor in weight gain and obesity is a very important and influential factor regarding food habits and physical activity among shift workers (Geliebter *et al.*, 2000, Mehri and Babri, 2021, Mehri *et al.*, 2019).

In the present study, the effect of shift work as well as the adjusted effect of other independent variables, including age, energy, carbohydrates, protein, fat, and dietary fiber intake, on BMI and WC were investigated. Multiple linear regression regarding shift work did not have a significant effect on BMI and WC. However, a significant relationship was observed between age and BMI as well as age and WC. Interventional studies demonstrated that a proper shift schedule improves biochemical parameters, and in contrast, using an inappropriate shift schedule causes weight gain in workers (Bøggild and Jeppesen, 2001, Yamada *et al.*, 2001). Therefore, it can be concluded that working environment and conditions can affect employees' nutritional status and eating habits, and the role of proper nutrition in preventing many physiological problems among shift workers should not be ignored.

Conclusions

There was no significant difference in food intake and overweight between shift and non-shift workers. However, according to the results of other studies such as changes in the sleep cycle and higher work stress in shift workers, and also reports of more diseases among shift workers. It is suggested that future studies be performed on a larger sample size and among other working groups as well.

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Authors' contributions

Mohit M and Golestaneh MA collected the data. Mousavinezhad H and Mohsenpour MA performed the analyses. Yousefinejad A received financial for undertaking this study. All authors contributed to writing the draft of the manuscript and revising it, and all authors have read and approved the final manuscript.

Conflict of interest

The authors declared no conflict of interest.

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