Original Article

Health and Nutritional Status of Irregular Shift-workers: A Cross-Sectional Study in South Zagros Oil and Gas Production Company

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Abstract

Background: Irregular working times or atypical working schedules, accompanied by the risk of unhealthy dietary habits, physical inactivity, and partial sleep deprivation, potentially lead to increased metabolic risk factors. This study aimed to evaluate the nutritional status, physical activity level, and the knowledge, attitude and practice (KAP) of South Zagros Oil and Gas Production Company (SZOGPC) employees (predominantly irregular-shift workers) toward diet and nutrition.

Methods: This cross-sectional study was conducted from January to October 2017 on 997 SZOGPC workers. Demographic characteristics, anthropometric measures, biochemical markers, physical activity status, KAP, and dietary intake of the employees were assessed and analyzed. The offered menus were also analyzed.

Results: The participants' mean age was 37.0±6.7 years; the majority of them were married (88.2%) and had irregular-shift work (85.6%). Approximately four-fifths of the participants were either pre-obese or obese, and two-thirds had central obesity. Over half of the participants had high serum triglyceride concentrations and inadequate high-density lipoprotein cholesterol levels. Alkaline phosphatase and alanine transaminase levels were higher than the normal range in 79.0% and 36.2% of the subjects, respectively. The KAP survey showed that only 28-31% of the interviewed participants had acceptable KAP subscale or total scores on the principles related to weight gain and obesity. The mean energy intake was almost 50% more than the average recommendations.

Conclusion: Irregular-shift workers appear to be at increased health risk, particularly in terms of acquiring non-communicable diseases. Effective lifestyle interventions such as nutrition education and basic menu changes must be considered as a major priority to promote health in such populations.

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Introduction

Non-communicable diseases (NCDs), including a wide variety of cardiovascular, gastrointestinal, renal, respiratory, endocrine, neurological, and malignant diseases are the primary cause of death on a global scale.[1] They account for more than two-thirds of all deaths worldwide, particularly in low- and middle-income countries and among the lower socioeconomic status populations of developed countries.[2]

NCDs are considered to be the consequence of a combination of genetic, physiological, environmental, and behavioral factors which impose a significant financial burden on the healthcare systems, negatively affecting both quality of life and life expectancy.[2] Unhealthy diet, physical inactivity, tobacco smoke exposure, and alcohol abuse increase the mortality risk of NCDs. These factors may also augment the so-called metabolic risk factors (obesity; increased blood pressure, glucose, and lipid levels), leading to the development of cardiovascular disease (CVD), as the predominant cause of premature deaths among NCDs.[3] To decrease the impact of NCDs on individuals and society, a low-cost solution is to focus on minimizing the common modifiable risk factors.

Extensive epidemiological studies indicate that irregular working times or atypical work schedules are accompanied by an increased risk of unhealthy eating habits. They include reduced diurnal meals, increased consumption of high-calorie snack foods and sugar-sweetened beverages during night shifts, and consumption of fast food and late-night meals. Low physical activity levels and partial sleep deprivation may further exacerbate the risk factors for metabolic disorders.[4-6]

Chronic health disorders of workforce members lead to decreased human resources and economic productivity, and the managment is costly to the healthcare system. Preventive strategies, thus, have always been emphasized alongside treatment programs. Various organizations, especially in developed countries, have been working to improve the health status of their employees.

Given the increasing prevalence of metabolic risk factors among irregular-shift employees together with the necessity of monitoring progress and trends of NCDs in guiding policies and priorities for health development, the present study aimed to evaluate the nutritional intake, physical activity, and knowledge, attitude, and practice (KAP) of South Zagros Oil and Gas Production Company (SZOGPC) employees toward diet and nutrition.

Methods

Study Population and Design

This descriptive cross-sectional study was conducted from January to October 2017 on 997 native and non-native SZOGPC workers in Iran. Non-native employees reside in the operational zone campus, located outside the county, for at least 14 to 20 days. With no accessibility to the county and edible raw or cooked products, their food choice was determined by the operational zone catering.

According to an occupational medicine assessment for early recognition and prevention of notifiable occupational diseases and industrial accidents, there was a high prevalence of abdominal obesity (66.9%) and dyslipidemia among the SZOGPC workers. In terms of dyslipidemia, elevated total and low-density lipoprotein cholesterol (TC and LDL-C, respectively) and triglyceride (TG) levels together with decreased high-density lipoprotein cholesterol (HDL-C) prevailed in 56.6% of the employees. Such an alarming health status demanded problem identification process through a comprehensive nutritional survey as the first step toward designing effective interventions. To this end, socio-demographic, anthropometric, and biochemical characteristics were evaluated. Data on self-reported physical activity, KAP, and dietary intake were collected using validated questionnaires. Besides, both regular and diet food menus offered by the catering service were analyzed in terms of nutritional content.

The research protocol, informed consent form, and questionnaires were approved by the Ethics Committee of Shiraz University of Medical Sciences (Code: IR.SUMS.REC.1398.1068). All data were collected after obtaining the consent of the participants.

Data Collection

Demographic Characteristics

Demographic data were collected on the participants' age, educational level, marital status, and occupational status level (whether a day or shift worker). Since data on smoking habits and alcohol consumption were found to be unreliable, the results were not reported.

Anthropometric Measures

The anthropometric indices, including weight, height, and waist and hip circumferences (WC and HC, respectively), were determined according to the standard protocols to the nearest 0.1 kg and 0.5 cm. WC and HC were measured above the iliac crest and at the maximal width of the buttocks, respectively. Both parameters were measured twice for intra-operator repeatability and repeated for the third time in the case of more than 2 cm variation between the initial assessments. The body mass index (BMI), computed as the ratio of the body mass (kg) divided by the height (m) squared, was then calculated along with the waist-to-hip and waist-to-height ratios (WHpR and WHtR, respectively). The cut-off points of BMI, WC, WHpR, and WHtR were considered as 23 kg/m2, 90 cm, 0.89, and 0.5, respectively.[7-9]

Biochemical Measurments

Blood samples were taken in the early morning of a working day after overnight fasting for at least 8 hours. The serum sugar and lipid profile were assessed, including fasting blood glucose (FBG; mg/dL), TG (mg/dL), TC (mg/dL), and HDL-C (mg/dL). Furthermore, both liver and kidney function were evaluated using the aspartate and alanine aminotransferase (AST and ALT, respectively; U/L), alkaline phosphatase (ALP; U/L), blood urea nitrogen (BUN; mg/dL), and creatinine (Cr; mg/dL) levels. The measurements were made calorimetrically using an auto-analyzer (Biotecnica, BT 1500, Rome, Italy) and the relevant commercial kits (Pars Azmoon, Tehran, Iran). The LDL-C (mg/dL) level was approximated using Friedewald's equation for those with TG<400 mg/dL,[10] while the estimated glomerular filtration rate (eGFR) was determined using the Cockcroft-Gault equation:[11]

LDL-C=[TC (mg/dL)–HDL-C (mg/dL)-TG (mg/dL)/5].

eGFR=[(140 - Age (year))× Weight (kg)/(Cr (mg/dL)×72]

The ratios of LDL-C, TC, and TG to HDL were also computed. Thyroid function assessment was also performed for triiodothyronine (T3; nmol/L), thyroxine (T4; nmol/L), and thyrotropin/thyroid-stimulating hormone (TSH; mIU/L). Levels for the routine cell blood count (CBC) parameters, including red and white blood cells (RBC, ×106/μL; WBC, ×109/L), hemoglobin (Hb; g/dL), hematocrit (Hct; %), mean corpuscular volume (MCV; fL), mean corpuscular hemoglobin (MCH; pg/RBC), mean corpuscular hemoglobin concentration (MCHC; g/dL RBC), and platelet count (×109/L) were measured by the means of a Sysmex K-1000 electronic cell counter (TOA Medical Electronics, Kobe, Japan). Analysis of the participants' biochemical parameters was performed by a nephrologist.

Physical Activity Assessment

Information on physical activity assessment was obtained using Baecke's Habitual Physical Activity Questionnaire (BHPAQ). The questionnaire consists of 16 items across three subscales, namely (1) work activity index (8 items), (2) sport activity index (4 items), and (3) leisure activity index (4 items)[12]. Activities were scored indivitually. The total activity score was computed by summing the points of the three components.

KAP Survey

Given our awareness of pre-obesity and obesity as the chief health problems among the study population, a validated KAP questionnaire was used as a standard tool to assess the perception of the subjects toward the related principles. It consisted of 54 items across the three dimensions of knowledge (20 items), attitude (14 items), and practice (20 items). Related areas of measurements were high-calorie food sources, healthy eating habits, effective strategies for weight control, and measures for preventing obesity and its related comorbidities. The participants were categorized into the three levels of poor, moderate, and good based on each section and the total score.

Dietary Intake Measurement

To study the participants' diet in terms of daily intake of energy and nutrients (carbohydrates, proteins, fats, water- and fat-soluble vitamins, and minerals), we used a 160-food-item dish-based food frequency questionnaire (FFQ). The questionnaire asked about the frequency of the employee's consumption of dietary items over the previous month, including days at home and at work, and was completed through face-to-face interviews conducted by expert dietitians. The FFQ was then analysed by Nutritionist IV diet analysis software modified for Iranian foods (version 3.5.2; 1994, N-Square Computing, First Data Bank Division, The Hearst Corporation, San Bruno, CA, USA). The daily intakes of nutrients were finally compared with the relevant recommended daily intakes (RDAs) and tolerable upper limit (UL) intakes provided for this age group.[13-18] To obtain a picture of the daily energy requirements (DER) of the participants, we used the individualized weight (either current body weight for normal-weight subjects or adjusted ideal body weight (IBW) for overweight or obese participants) and physical activity levels (PAL), the average of which was considered as the reference DER value recommended for adult males in the study population (~2800 kcal/day).

Dietary Analysis of the Menu

Two menus were offered in the Parsian food service, i.e., a regular- diet menu as a varietay of dishes typical of the Iranian culinary tradition and a 'modified-diet' menu for those seeking to eat a healthier version of regular-diet menu. Analysis of the two menus was conducted in terms of the season (spring, summer, autumn, and winter; each with a two-week (14-day) routine of daily recipes). The menu consisted of three meals, each with two choices of 'regular' and 'diet' with the exception of dinners. Dinners had an additional option of 'ready-to-eat' for those seeking to have a quick meal. Besides, an additional light midnight meal was offered to employees who had night shifts. The exact weight (g) of every constituent of the recipes (except added salt) provided by the SOGPC catering was subjected to analysis by Nutritionist IV software modified for Iranian foods and were computed for each meal and day. The average of every 14 consecutive values of each season was considered representative of the seasonal average intake.

Statistical Analysis

Data processing was conducted by the use of IBM SPSS Statistics version 21.0 (IBM Corp., Armonk, NY, USA). Qualitative and quantitative data were represented as absolute count (percentage) and mean±SD, respectively. RDA and UL fulfillment of nutrient intake were expressed as percentages. The one-sample t-test was used for comparing the mean intake with the RDA of the respective nutrients at a 0.05 level of significance.

Results

Demographic Characteristics

The general characteristics of the participants are displayed in Table 1. As seen, the mean age was 37.0±6.7 years, and the majority of workers were married (88.2%) and had shift work (85.6%). Besides, more than half of the studied participants (51.6%) were found to be inactive.

Anthropometric Measures

Table 2 shows the anthropometric indices of the workers. More than four-fifths of the studied workers were categorized in the pre-obese or obese weight range (BMI≥23) based on the Asian BMI classification of the World Health Organization (WHO). Only 15% had normal weight (18.5≤BMI<23.0). As expected, two-thirds of the study population had central obesity (WC≥90 cm).

Table 1: Demographic characteristics of the study subjects

Parameter	N	n (%)
Age (y)	951	37.0±6.7**
20-35		444 (46.7)
36-50		464 (48.8)
51-65		43 (4.5)
Marital status	954	
Single		113 (11.8)
Married		841 (88.2)
Educational level*	920	
Low		384 (41.7)
Middle		113 (12.3)
High		423 (46.0)
Occupational status level	716	
Day workers		103 (14.4)
Shift workers§		613 (85.6)
Physical Activity	905	
Work activity index		2.6±0.7
Sport activity index		2.5±0.8
Leisure activity index		2.5±0.6
Total activity score		7.6±1.5

*Subjects were classified as low (<12 years), middle (12-15 years), or high (≥16 years) based on the total years of pursuing education. §Shift workers with on and off two-week working periods. **Value is given as mean±standard deviation

Table 2: Anthropometric characteristics of the participants

Parameter	N	Mean±SD/n (%)	Reference Value
Wt. (kg)	936	78.84±12.03	
BMI (kg/m^2)	929	26.15±3.58	18.5-23.0
<18.5		14 (1.5)	
18.5-23.0		137 (14.7)	
23.0-27.5		492 (53.0)	
27.5-32.5		237 (25.5)	
>32.5		49 (5.3)	
WC (cm)	896	94.2±8.6	< 90
<90		297 (33.1)	
≥90		599 (66.9)	
HC (cm)	897	100.8±7.1	-
WHpR	896		0.9
<0.9		186 (20.8)	
≥0.9		710 (79.2)	
WHtR	887	0.54±0.05	0.5†
<0.5		149 (16.8)	
≥0.5		738 (83.2)	

†Miralles CS, Wollinger LM, Marin D, Genro JP, Contini V, Dal Bosco SM. Waist-to-height ratio (WHtR) and triglyceride to HDL-C ratio (TG/HDL-c) as predictors of cardiometabolic risk. Nutrición hospitalaria. 2015;31(5):2115-21. *Subjects were classified as underweight (BMI<18.5), normal weight (18.5<BMI<=23.0), overweight (23.0<BMI<=27.5), and obese (27.5<BMI<=32.5, and BMI≥32.5) based on the BMI. Wt., weight; BMI, body mass index; WC, waist circumference; HC, height circumference; WHpR, waist to hip ratio; WHtR, waist-to-height ratio

Biochemical Assessment

As revealed in Table 3, based on the CBC, blood abnormalities were not common among the participants. Among the glycemic markers, the only factor measured was the FBG. Although a small part of the population (<9%) was in the borderline or high range, further biochemical and clinical assessments are necessary for confirmation of diabetic diagnosis. The mean serum TG concentration was above the cut-off value (150 mg/dL) in more than half of the study population (56.7%); inadequate HDL-C levels (<40 mg/dL) were detected in almost the same percentage of participants. The atherogenic lipid risk factors of the study population (TC/HDL, LDL/HDL, TG/HDL) ranged between 39 and 58%, predisposing the participants to high cardiovascular risk (Table 3). Among the biochemical markers of liver function, elevated values were demonstrated in the ALK-P and ALT markers in 79.0% and 36.2% of the employees, respectively. Moreover, the thyroid function components were normal. Regarding the kidney function, low eGFR values were recognized in ~14% of the participants.

KAP Survey

The results of the KAP survey are represented in Table 4. The findings showed that only 28-31% of the interviewed participants had accurate knowledge, attitude, and/or practice on the principles related to pre-obesity and obesity.

Dietary Intake Measurement

The analyses of the dietary data indicated that the energy intake of the participants was 3873±960 kcal, almost 50% more than the recommended value based on the average individualized DER (Table 5); this is compatible with the anthropometric findings.

Table 3: Biochemical parameters of the study subjects

Parameter	N	Mean±SD/n (%)	Reference Value	N (%) above normal range*
CBC				
WBC (×10⁹/L)	989	7.4±1.8	5-10	66 (6.7)
RBC (×10⁶/µL)	989	5.6±0.5	4.7-6.1	131 (13.2)
Hb (g/dL)	989	15.4±1.2	14-17	64 (6.5)
HCT (%)	989	49.8±3.4	42-52	230 (23.2)
MCV (fL)	989	89.6±7.3	82-99	49 (5.0)
MCH (pg/RBC)	989	27.8±2.6	27-31	50 (5.0)
MCHC (g/dL RBC)	989	30.9±1.0	32-36	0 (0.0)
Platelet (×10⁹/L)	989	232.3±46.2	150-400	2 (0.2)
Biochemical parameters				
FBS (mg/dL)	997	87.4±14.5	<100	87 (8.7)
			100-125	14 (1.4)
TG (mg/dL)	997	190.2±109.4	<150	547 (57.6)
TC (mg/dL)	997	180.4±35.0	<200	263 (26.4)
			200-239	49 (4.9)
LDL-C (mg/dL)	949	104.2±29.1	<130	153 (16.1)
HDL-C (mg/dL)	997	39.7±9.8	>40	564 (56.6)
LDL-C/HDL-C	949	2.7±0.9	<2.5	546 (57.5)
TC/HDL-C	997	4.7±1.2	<5	388 (38.9)
TG/HDL-C	989	5.2±3.7	<3.88†	561 (56.7)
LFT				
AST (U/L)	989	23.7±9.7	0-35	84 (8.5)
ALT (U/L)	989	36.3±23.5	4-36	358 (36.2)
ALK-P (U/L)	989	153.2±40.1	30-120	781 (79.0)
TFT				
T_3 (nmol/L)	687	1.9±0.4	1.2-3.4 (for 20-50 y)	3 (0.4)
			0.6-2.8 (for >50 y)	(13.3) 6
T_4 (nmol/L)	989	103.5±19.0	51-154	16 (1.6)
TSH (mIU/L)	989	2.8±3.8	0.2-5.5	66 (6.7)
KFT				
BUN (mg/dL)	989	12.4±3.1	7-23	3 (0.3)
Cr (mg/dL)	989	1.0±0.1	0.6-1.5	1 (0.1)
eGFR (mL/min)	724	114.0±48.6	≥90	99 (13.7)

* Noland D, Litchford M. Appendix 22: Laboratory values for nutritional assessment and monitoring. Krause's food and the nutrition care process. 14th ed. St Louis, Missouri: Elsevier. 2017:981-1001. †Miralles CS, Wollinger LM, Marin D, Genro JP, Contini V, Dal Bosco SM. Waist-to-height ratio (WHtR) and triglyceride to HDL-C ratio (TG/HDL-c) as predictors of cardiometabolic risk. Nutrición hospitalaria. 2015;31(5):2115-21. CBC, cell blood count; RBC, red blood cells; WBC, White blood cells; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; FBS, fasting blood sugar; TG, triglyceride; T-C, total cholesterol; LDL-C, LDL-cholesterol; HDL-C, HDL-cholesterol; LFT, liver function test; AST, Aspartate aminotransferase; ALT, alanine aminotransferase; ALK-P, alkaline phosphatase; TFT, thyroid function test; T3, triiodothyronine; T4, thyroxine; TSH, thyrotropin/thyroid stimulating hormone; KFT, kidney function tests; BUN, blood urea nitrogen, Cr, creatinine.

Table 4: Knowledge, attitude, and practice (KAP) of the study subjects toward principles related to pre-obesity and obesity

Parameter	N	n (%)
Knowledge	353	
Poor		116 (32.9)
Moderate		126 (35.7)
Good		111 (31.4)
Attitude	353	
Poor		102 (28.9)
Moderate		151 (42.8)
Good		100 (28.3)
Practice	353	
Poor		102 (28.9)
Moderate		150 (42.8)
Good		101 (28.6)
Total score	353	
Poor		92 (26.1)
Moderate		172 (48.7)
Good		89 (28.3)

Table 5: Dietary intake of the participants (N=948)

Elements	Daily intake				RDA	UL	Mean contribution to		P2.5 contribution to RDA (%)	P97.5 contribution to UL (%)	<2/3 RDA%[a]	>UL%[b]
	P2.5	P50	P97.5	Mean±SD			RDA (%)	UL (%)				
Energy (Kcal)	2138.6	3788.8	5985.7	3873.3±960.4†	ND	ND	147	NA	NA	NA	NA	NA
Protein (g)	84.0	159.0	267.7	160.3±46.0†	56	ND	286	NA	NA	NA	0.0	NA
CHO (g)	268.1	521.1	748.2	519.0±112.6	ND	ND	NA	NA	NA	NA	NA	NA
Fat (g)	72.1	121.8	228.4	128.4±41.2	ND	ND	NA	NA	NA	NA	NA	NA
SFA (g)	10.2	25.2	49.7	26.5±10.5†	ND	ND	130	NA	NA	NA	NA	NA
PUFA (g)	9.4	22.5	37.9	22.9±7.4†	ND	ND	79	NA	NA	NA	NA	NA
Cholesterol (mg)	109.9	357.4	937.2	413.0±239.9†	ND	ND	138	NA	NA	NA	NA	NA
Iron (mg)	5.5	14.1	29.7	15.1±6.4†	8	45	189	34	69	66	2.0	0.3
Magnesium (mg)	206.6	438.5	732.6	447.8±135.6†	420[€]	ND	107	NA	49	NA	9.2	NA
Zinc (mg)	5.6	13.0	23.1	13.5±4.7†	11	40	123	34	51	58	6.6	0.1
Manganese (mg)	1.9	4.6	8.7	4.8±1.8†	2.3	11	208	44	83	79	1.2	0.5
Potassium (mg)	2106.5	4324.4	7790.4	4520.0±1662.8‡	4700	ND	96	NA	45	NA	17.0	NA
Sodium (mg)*	856.5	2225.1	5582.2	3275.5±1238.2	1500	2300	218	142	57	243	3.8	46.8
Calcium (mg)	360.8	1195.3	3170.7	1333.0±740.7†	1000	2500[€€]	133*	53	36	127	15.1	7.2
Phosphorus (mg)	658.1	1756.2	3668.6	1873.1±761.5†	700	4000	267	47	94	92	0.5	1.5
Copper (μg)	651.4	1541.9	4007.8	1826.6±1014.8†	900	10000	203	18	72	40	1.7	0.1
Chromium (μg)	1.16	3.5	10.0	39.9±28.1†	35	ND	114	NA	3	NA	17.8	NA
Selenium (μg)	0.1	108.9	224.6	111.5±50.9†	55	400	203	28	0.2	NA	5.5	0.1
Vitamin E (mg)	3.5	13.9	23.9	14.0±5.0†	15	ND[b]	93	NA	23	NA	19.0	NA
Vitamin C (mg)	47.2	124.8	364.1	143.0±94.7†	90	2000	159	NA	52	NA	4.4	0.0
Vitamin K (μg)	55.6	214.6	447.8	225.5±103.4†	120	ND[a]	188	NA	46	NA	4.8	NA
Thiamine (mg)	0.9	2.3	5.3	2.4±1.1†	1.2	ND[a]	200	NA	75	NA	1.9	NA
Riboflavin (mg)	0.7	2.6	7.2	2.9±1.7†	1.3	ND[a]	223	NA	54	NA	5.0	NA
Niacin (mg)	10.1	21.9	39.5	22.3±7.6†	16	ND[b]	139	NA	63	NA	3.9	NA
pyridoxine (mg)	0.9	1.8	3.2	1.9±0.7†	1.3	100	146	2	69	3	2.3	0.0
Cobalamine (μg)	1.0	3.1	32.5	9.2±12.5†	2.4	ND[a]	383	NA	42	NA	13.1	NA
Biotin (μg)	8.3	22.8	60.3	24.8±12.9†	30	ND[a]	83	NA	28	NA	39.2	NA
Folic acid (μg)	216.2	520.9	925.5	537.3±185.2†	400	ND[b]	134	NA	54	92	5.1	NA
pantothenic acid (mg)	2.6	5.8	10.9	6.1±2.5†	5	ND[a]	122	NA	52	NA	6.0	NA

‡ P<0.05; † P<0.001; [€]Magnesium RDA is set on 400 and 420 mg, respectively for 19-30 and 31+ year male adults. Since the average age of the population was about 37.0 years, 420 was served as the comparison value. [€€]Calcium UL is set on 2500 and 2000 mg, respectively for 20-50 and 51+ year male adults. Since the average age of the population was about 37.0 years, 2500 was served as the comparison value. ND: Not determined; NA[a]: Not applicable

As shown in Table 5, the intake of nutrients ranged between 79-383% of the daily recommended value. The dietary intakes of protein, sodium, and cholesterol exceeded their respective nutritional recommendations (2.8, 2, and 1.4 times higher, respectively) as well.

Dietary Analysis of the Menu

Table 6 describes the menu options offered by the SZOGPC catering: regular and diet. Notably, the calorie content of both menus was significantly higher than the recommended reference level (4583 and 3683 kcal, respectively, vs. 2621 kcal; $P<0.001$ for both). Similar trends were also observed with the content of most macro- and micro-nutrients in both menus (Table 6). Moreover, although the saturated fatty acid (SFA) content of both menus comprised 7% of the total energy content, the absolute amount of SFAs may be higher than the recommended limits considering that the total calories were quite high.

The protein quantities of both menus was 300% more than the dietary reference intakes (DRIs) proposed by the Food and Nutrition Board of the US National Academy of Sciences.[14] Not considering the added salt (either in food recipes or the table salt), the sodium content of the the regular and diet menu was ~370% and ~85% of the DRI, respectively. Sodium intake of the participants, thus, exceeded the recommended values. Finally, the phosphorus content was four times higher than the relevant DRI in both menus.

Discussion

Since economic productivity and sustainable development represent vital issues for all countries, both governments and healthcare systems have sought to promote the health status of human resources. In this cross-sectional study of Parsian SOGPC employees, anthropometric features, physical activity status, biochemical indices, energy intake, and dietary macro- and micro-nutrient contents were evaluated. The two menus (regular or diet) offered by the catering service were also compared with each other and with the daily recommendations.

Our findings revealed that more than half of the workers were inactive and had dyslipidemia (either increased TG or decreased HDL-C). A majority

Table 6: Nutrient components of the regular and diet menu offered by the SOGPC catering service

Parameter	Reference Value	Regular Menu		Diet Menu		P value
		Mean±SD	Daily value (%)	Mean±SD	Daily value (%)	
Energy (Kcal)	ND	4583.8±167.3†	175	3683.8±124.0†	141	0.029
Protein (g)	56	176.0±9.0†	314	182.8±10.0†	325	0.486
CHO (g)	ND	590.4±14.5	NA	491.7±18.8	NA	0.029
Fat (g)	ND	172.2±10.3	NA	111.6±3.0	NA	0.029
SFA (g)	20.4	35.3±1.7†	173	29.0±1.2‡	142	0.029
PUFA (g)	29.1	51.7±3.6‡	178	26.4±26.2‡	91	0.029
MUFA (g)	29.1	71.3±4.4†	245	44.8±1.9†	154	0.029
Cholesterol (mg)	300	470.2±22.6‡	157	497.2±44.4‡	166	0.343
Iron (mg)	8	31.0±2.4†	387	25.6±2.3‡	320	0.057
Magnesium (mg)	420	635±23.6†	151	553.7±27.2‡	132	0.029
Zinc (mg)	11	20.5±1.0†	186	15.6±1.0‡	142	0.029
Manganese (mg)	2.3	9.2±0.4†	400	7.7±0.5†	335	0.029
Potassium (mg)	4700	5700.0±300.0‡	121	5600.0±200.0‡	119	0.486
Sodium (mg)*	2400	5500.0±1000.0‡	367	1300.0±40.0‡	86	0.029
Calcium (mg)	1000	1875±68.0†	187	1781.8±61.8†	178	0. 200
Phosphorus (mg)	700	3045.0±154.0†	435	2982.0±134.6†	426	0.686
Copper (µg)	900	2993.0±192.0†	332	2497.0±238.0‡	277	0.057
Chromium (µg)	35	42.2±3.1‡	120	55.8±9.2‡	159	0.029
Selenium (µg)	55	96.2±13.1‡	175	108.7±7.9‡	198	0.200
Iodine (µg)*	150	Trace	-	Trace	-	-
Vitamin E (mg)	15	54.1±3.0†	361	28.6±0.7†	191	0.029
Vitamin C (mg)	90	171.0±8.0†	190	167.6±5.2†	186	0.886
Vitamin D (µg)	15	0.8±0.02†	5	0.9±0.1†	6	0.686
Vitamin K (µg)	120	353.0±33.0‡	294	339.0±33.0‡	282	0.686
Thiamine (mg)	1.2	3.4±0.3†	283	3.4±0.2†	309	0.057
Riboflavin (mg)	1.3	4.1±0.1†	315	4.0±0.1†	307	0.114
Niacin (mg)	16	51.8±3.1†	324	61.5±4.0†	384	0.029
pyridoxine (mg)	1.3	4.0±0.5‡	308	4.1±0.5‡	315	1.000
Cobalamine (µg)	2.4	4.7±0.3‡	196	3.1±0.1‡	129	0.029
Biotin (µg)	30	17.3±2.2‡	58	15.4±2.2‡	51	0.486
Folic acid (µg)	400	834.0±59.0‡	208	731.0±59.0‡	183	0.114
Pantothenic acid (mg)	5	8.0±0.6‡	160	8.3±0.4†	166	0.486

‡ $P<0.05$; † $P<0.001$

(>80%) were either overweight or obese, and two-thirds of the individuals possessed abdominal obesity. Among the probable causative factors of the observed metabolic disorders is the food menus offered to the population. Menu analysis demonstrated that the mean energy and nutrient contents were more than the usual need, probably leading to weight gain and visceral obesity. Since most of the employees reside within the campus for 14-20 days per month, they have no access to food choices in the county area other than those offered by the catering service. On the other hand, the sedentary lifestyle could further aggravate the situation and increase the risks of dyslipidemia (particularly low HDL-C levels).

Another finding of this study was that less than one-third of the studied population had desirable KAP (according to individual component scores and total score) toward healthy eating principles. The low total KAP score may mean that the employees would sparsely feel the need for choosing the diet menu over the regular menu. On the other hand, it appears that the principles of healthy eating were not likely to be followed at home either. The findings on the dietary intakes of the participants estimated by FFQ, however, could further approve such hypotheses. According to the observations, employees with higher total KAP scores were probably the ones who chose the diet menu or 'ready-to-eat' dinner as they wished to choose healthier food options. However, analysis of the nutritional composition of these menus revealed that these options were not as healthy as imagined. It should also be noted that the mean dietary intakes of energy and nutrients from the FFQ were much higher than the recommended values. This may explain the anthropometric and biochemical results.

Comparison of daily energy intake of SZOGPC employees (3875 kcal) with the mean DER recommended for an adult male (~2800 kcal/day) showed that the energy intake of the study population was approximately 1.5 times higher. Excess energy intake is thought to be a major contributor to obesity and metabolic disorders, including CVD, nonalcoholic fatty liver disease (NAFLD), type 2 diabetes, different types of cancer, and so on.[19] Apart from the well-known risk factors such as poor diet and sedentary lifestyle, epidemiological studies have detected that shorter sleep times and irregular shift work are causally linked with obesity and metabolic diseases.[20] Ostry et al.[21] indicated a positive association between high workload, long working hours, and BMI, which affirms the influence of organizational factors on the occurrence of pre-obesity and obesity.[22]

Desynchronization of circadian rhythms, behavioral disruption, and biochemical factors involved in energy balance may explain the high rate of pre-obesity and obesity in the study population, indicating probable links between irregular shift work, energy metabolism, and body weight regulation.[23] Some of the SZOGPC employees also consumed midnight meals at a time when postprandial thermogenesis is lower[24] and the body is not prepared for energy consumption. Therefore, it seems that the quality and quantity of food, as well as the meal consumption patterns, can be affected by the working conditions.[23] Concerning the eating habits, workers were affected by several factors, such as food supply, work type, and the environment. Likewise, in terms of the frequency and type of meals among the workers, the role of time limitations was greater than that of hungry feelings.[25]

In the present study, significant differences were found between protein, cholesterol, sodium, and phosphorus intake and their respective RDA values. Concurrent with the menu components supplied by the SOGPC catering, these disproportionate intake levels can be harmful in several ways. Firstly, the extra protein intake cannot be used efficiently by the body and may impose a metabolic burden on the bones, kidneys, and liver. The high intake of protein, especially animal protein given its acidogenic content (sulfur-containing amino acids), decreases the urinary pH, which is buffered in part by bone tissue through the release of calcium to be excreted by the kidney. This excessive calcium loss of the bone consequently results in exorbitant bone loss. Moreover, high protein intake is an important risk factor for the development of kidney stones. Protein-induced hypercalciuria can lead to the formation of calcium kidney stones.[26] Furthermore, animal protein is considered to be the major dietary source of purines, the precursors of uric acid. Excessive intake of animal protein is, therefore, associated with hyperuricosuria, a condition present in some uric acid stone formers.[27] Besides, high-meat diets may also be accompanied by a higher risk of coronary heart disease (CHD) due to the high SFA and cholesterol content; links with colorectal cancer are also possible given the formation of heterocyclic amines in cooked meat. Notably, the SFA content of red meat has been associated with breast and colorectal cancer. Hyperalbuminemia and elevated transaminases, associated with a high-protein diet, may precipitate the progression of liver disease. Secondly, high cholesterol is a significant risk factor for CHD and a cause of atherosclerosis and myocardial infarction.[26] Third, excess dietary sodium has been linked to elevations in blood pressure (BP) due to alterations in the fluid volume; fluid regulatory hormones; and vasculature, cardiac, renal and autonomic function. Indeed, recent preclinical and clinical studies emphasize that sodium can adversely affect multiple target organs including the blood vessels, heart, kidneys, and brain, even in the absence of an increase in blood pressure.[28] Fourthly, long-term dietary phosphorus loads and long-term hyperphosphatemia may have important adverse effects on the bone health through the induction of higher serum concentrations of parathyroid hormone (PTH) and serum fibroblast growth factor 23 (FGF23), along with lower serum calcium concentrations in healthy individuals. Adequate dietary calcium intake is needed to overcome the interfering effects of high phosphorus intake on PTH and FGF23 secretion.[29] Even though a high intake of protein and phosphorus may lead to several metabolic consequences, neither of the mentioned complications was found among the employees because their intake was lower than the recommended upper limit (UL). It is strongly recommended that a major modification of the menu should be performed to prevent serious complications in the long run.

Biotin was the only nutrient consumed less than the respective recommended reference values. As a water-soluble and essential nutrient, biotin can be found in many food items, including whole grains, dairy products, nuts, some vegetables, egg yolk, liver, and soya.[30] However, the menus offered to the employees failed to contain adequate amounts of whole grains, soya, and nuts, which may explain the inadequate biotin content.

Conclusion

In the present cross-sectional study, the nutrition intake, physical activity status, and KAP toward obesity were investigated in a sample consisting predominantly of irregular-shift workers. Based on the results, the vast majority of employees were found to have obesity and met at least two or three of the metabolic syndrome criteria. Shift work can result in a low-quality diet and irregular eating patterns, consequently creating an unfavorable metabolic phenotype that facilitates the development and progression of chronic diseases. Implementation of effective interventions such as nutrition and lifestyle education, health promotion programs, as well as menu manipulations, must be prioritized.

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