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Short Communication

Impact of Shift Work on the Eating Pattern, Physical Activity and Daytime Sleepiness Among Chilean Healthcare Workers

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ABSTRACT

We evaluated the eating pattern, physical activity, and daytime sleepiness level in Chilean shift workers. Fifty, middle-aged adult health workers from a public hospital in Santiago, Chile, were included: a group undergoing shift work (shift workers, including at least one "night shift" and one "long day", n = 33), and day workers under traditional schedule (from 8:00 to 17:00h, n = 17). Body composition, physical activity, and daytime sleepiness levels, and diet characteristics (diet composition, meals' timing, and diet quality) were assessed. Despite similar total energy intake, shift worker showed lower carbohydrate (% of energy) and higher protein intake (both $P < 0.01$), decreased diet quality, an irregular eating pattern, and delayed meal timing (all $P < 0.05$). Physical activity and daytime sleepiness levels did not differ between groups. Findings from this first Chilean study in healthcare shift workers support the fact that meal timing and diet quality appear as critical factors for upcoming intervention studies in this group.

1. Introduction

Shift work (SW) is commonplace in Westernized societies representing a high proportion of the working force worldwide [1]. Evidence in humans has shown the adverse health effects of SW, disturbing the circadian rhythms and the sleep–wake cycle, and increasing the risk for chronic noncommunicable diseases [2]. An altered diet structure has been reported in shift workers [2–4], and SW is positively associated with obesity risk [1,5]. In Chile, around 25% of health and private companies include shift working [6], but the relevance of SW on health-related behaviors is unknown. We evaluated the diet, physical activity, and daytime sleepiness level in Chilean healthcare shift workers and day workers.

1.1. Subjects and design

This was an exploratory, cross-sectional study. We included fifty adult healthcare workers, between aged 18–65 years, having a traditional or rotating work schedule, all belonging to the Dr. Exequiel González Cortés Hospital, Santiago, Chile. Exclusion criteria were decompensated chronic disease (uncontrolled thyroid disease, genetic dyslipidaemias, severe hypertriglyceridemia and hypercholesterolemia, morbid obesity), eating disorders, psychiatric disorders, and participants who have had a dietary regimen during the last 30 days.

Shift workers' group (n = 33) included health workers following rotating SW with a weekly schedule of at least one 'night shift', one 12-hour (or 'long day') shift, and two consecutive days off. Every health worker performing SW followed this workload continuously. Therefore, shift workers performed night shift two days a week. Day workers' group (n = 17) included health workers working Monday to Friday, from 8:00 to 17:00h.

The study protocol was evaluated by the Institutional Review Board of the Faculty of Medicine, University of Chile, Santiago, Chile (040-2014), according to the Declaration of Helsinki. The Committee for People Responsibility of Dr. Exequiel Gonzalez Cortés Hospital approved the study aims and design. All participants were informed about the aims and characteristics of the study and their right to refuse to participate at any time, through an initial assembly with the entire Hospital Community. Therefore, it was considered that the participants, who responded to the invitation and attended the evaluations, consented to their participation.

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1.2. Evaluations

A physician conducted a clinical evaluation focused on anamnesis and evaluation of overall health status. Nutritional evaluation included the assessment of body composition (by electrical bioimpedance, Inbody S10, Inbody Co., Ltd Inbody Bldg. Seoul, Korea) and anthropometry (weight and height, Seca 700, Seca®, Hamburg, Germany; waist, hip, and neck circumferences were also assessed. Physical activity level was estimated by the International Physical Activity Questionnaire [7]. Daytime sleepiness was estimated using the Epworth Sleepiness Scale [8], an internationally validated instrument assessing daytime sleepiness under everyday life situations. A total sleepiness score is obtained, and sleepiness was categorized as moderate (total score $\geq$ 10) or severe (total score $\geq$ 15).

A 24-hour recall (24hR) and a food history record evaluated dietary characteristics. Individual information about the clock time and type of each meal, details on foods/beverages, the number of serving portions, and foods' commercial labels was obtained. Diet's nutritional composition was analyzed using the software Food Processor SQL® (ESHA Research, Salem, OR, USA).

Diet quality was assessed using an adapted version of the Healthy Eating Index (HEI) proposed for the United States of America population, adapted to the Chilean healthy dietary guidelines for adults [9]. This adapted diet quality index evaluated the compliance with daily recommended consumption of food groups (portions/day) of cereals, vegetables, fruits, dairy products, and meats as components of a healthy diet for the Chilean population. The intake of total fat (% of total energy), saturated fat (% of total energy), sugars (% of total energy), sodium (g/day), and the diversity of the diet (based on compliance above or below 25% of the recommended portions of the five analyzed food groups) are also components of the index. A score from 0 to 10 points is calculated for each component based on the achievement of recommended food portions/day or nutrients intake/day (as % of total energy). For each component, a score of 10 points means better compliance with healthy diet recommendations. Finally, the overall quality index score was calculated as the sum of the individual components' scores [9].

1.3. Statistical analysis

Data are shown as mean ± SEM or median (interquartile range) in accordance with the distribution of variables, as assessed by the Shapiro Wilk test. To compare differences in categorical variables distribution between both groups, the Chi-square or Fisher's exact test was used. Based on the analysis of variables' distribution, differences between groups regarding background characteristics and diet assessment were assessed using student t test (for parametrically distributed variables) or Wilcoxon rank sum test (for nonparametrically distributed variables). The significance level was set at an α-level of 5%. STATA® v.13.1 (Stata Corporation, College Station, TX) was used for analyses and GraphPad Prism 6.0 (GraphPad Prism Software, Inc. San Diego, CA) for figure processing.

1.4. Results

No differences regarding age, gender, BMI, percentage of body fat, and anthropometrical parameters were observed between groups (Table 1). In addition, the time allocated to perform physical activities of different intensities did not differ, with only a trend to reduced time spent walking in shift workers ($P = 0.085$). Daytime sleepiness level score, as well as the proportion of participants having moderate or severe daytime sleepiness, was also similar (Table 1).

Total energy intake did not differ between both groups (Table 2). Likewise, absolute protein and fat intake was similar, but absolute carbohydrate intake was lower in shift workers. A higher proportion of energy coming from proteins and fats and a lower proportion of energy coming from carbohydrates were found in shift workers (all $P < 0.05$, Fig. 1a). However, micronutrient/vitamins intake showed poor adequacy against daily recommendations for the whole sample, without group differences (see Supplementary Table S1).

Overall diet's quality index and quality scores for vegetable, total fat, and saturated fat intake were diminished in shift workers (all $P < 0.05$, Fig. 1b). Shift workers showed lower meal frequency ($P < 0.006$), greater skipping of main meals (Fig. 1c and d), and food intake in the early morning hours (from midnight to 6 am $P < 0.05$,

Table 1
General characteristics

Variable	All (n = 50)	Day workers (n = 17)	Shift workers (n = 33)	*P* value*
Age, years	37.1 ± 1.8	38.8 ± 3.4	36.2 ± 2.2	0.52
Gender, M/F†	3/50	1/16	2/31	0.99
Weight, kg	72.7 ± 2.2	76.4 ± 5.3	71.1 ± 2.3	0.38
BMI, kg/m^2	29.5 ± 1.0	30.7 ± 2.3	29.0 ± 1.1	0.49
Overweight, n (%)	35 (70)	11 (64.7)	24 (72.7)	0.99
Obesity, n (%)†	16 (32)	5 (29.4)	11 (33.3)	0.74
Waist circumference, cm	90.5 ± 2.2	93.4 ± 5.1	89.2 ± 2.3	0.46
WHR	0.85 ± 0.01	0.86 ± 0.02	0.85 ± 0.01	0.60
Neck circumference, cm	34.7 ± 0.5	35.4 ± 1.0	34.4 ± 0.6	0.39
Body fat, %	40.8 ± 1.1	39.8 ± 1.9	41.3 ± 1.2	0.54
Physical activity, intense (min/sem)	0 (0-360)	0 (0-0)	0 (0-420)	0.463
Physical activity, moderate (min/sem)	0 (0-240)	0 (0-240)	0 (0-120)	0.399
Physical activity, low-intensity (min/sem)	214.5 (49.5-792)	231.0 (99-990)	214.5 (24.7-792)	0.692
Walking, min/sem	120 (60-150)	120.0 (120-180)	120.0 (60-120)	0.085
Sleepiness score, points	10.0 ± 0.7	10.6 ± 1.2	9.5 ± 0.8	0.554
Moderate daytime sleepiness, n (%)†	25 (50)	9 (18)	16 (32)	0.845
Severe daytime sleepiness, n (%)†	9 (18)	4 (8)	5 (10)	0.496

Data as mean ± SEM or as a percentage (%), unless otherwise indicated.
* Between groups comparison using student t test or Wilcoxon rank sum test, unless otherwise indicated.
† Comparison between groups using Fisher's exact test. M: masculine; F: female; BMI, body mass index: kg/m^2; WHR: waist-to-hip ratio.

Table 2
Nutritional composition of diet

Dietary intake	Day workers (n = 17)	Shift workers (n = 33)	*P* value
Energy intake, kcal	2494.6 ± 270.7	2041.7 ± 111.2	0.142
Foods/beverages intake, g	2351.5 ± 264.3	2151.1 ± 119.1	0.498
Energy density, kcal/g	1.0 ± 0.1	0.9 ± 0.03	0.391
Protein, g	75.5 ± 7.1	78.5 ± 4.6	0.689
Carbohydrate, g	372.3 ± 48.1	263.9 ± 15.9	**0.050**
Fat, g	78.3 ± 9.7	74.6 ± 6.4	0.754
Dietary fiber, g	23.2 ± 2.5	21.9 ± 1.9	0.677
Saturated fat, g*	3.4 (14.6)	4.4 (20.7)	0.709
Monounsaturated fat, g*	0.2 (45.6)	0.9 (48.8)	0.439
Polyunsaturated fat, g*	0.06 (20.9)	1.0 (36.2)	0.908
Cholesterol, mg*	209.4 (155.7)	219.5 (139.7)	0.841
Trans fatty acids, g*	1.3 (1.3)	0.3 (0.9)	0.141
Omega 3 fatty acids, g*	0.4 (0.7)	0.4 (0.4)	0.975
Omega 6 fatty acids, g*	3.5 (3.3)	2.6 (2.4)	0.243
Omega6/omega 3, ratio*	6.6 (5.1)	5.2 (5.6)	0.147
Caffeine, mg*	175.2 (131.6)	164.8 (156.0)	0.785

Data as mean ± SEM or. Bold *P* values depict significant differences for comparison between Day workers and Shift workers.

* Median (p25-p75). Diet's nutritional composition was analyzed using Food Processor SQL® (ESHA Research, Salem, OR, USA).

data not shown), and a later onset time of teatime and the last meal of the day (Fig. 1e).

1.5. Discussion

Ours is the first study describing diet, physical activity, and daytime sleepiness characteristics in Chilean healthcare shift workers. Dietary pattern was disturbed in shift workers with altered meal timing and diminished diet's quality. The disorganized meal pattern suggests that dietary disturbances are among the main behavioral consequence of shift work in this sample.

Studies assessing daily energy intake in shift workers against day workers are inconsistent [10–12]. Our results are in line with a meta-analysis showing that total energy intake did not differ between shift workers and day workers [10]. Evidence concerning total macronutrient intake between shift workers and day workers is also contrasting, with the differences being in agreement with some but not all previous studies [12]. In this sense, the methodological features (mainly cross-sectional studies) of different studies, as well as the assessment of outcomes, and different population's characteristics could help to explain at least in part this discrepancy.

International recommendation proposes acceptable daily macronutrient distribution for protein as 10–35% of total energy whereas, for carbohydrates and fats, figures are 45–65% and 20–35%, respectively [13]. In our study, the respective proportions of macronutrients were mostly in line with those recommendations. However, fat intake was even higher than the national recommendation (less than 30% of total energy) as part of a healthy diet. The higher proportion of energy from proteins and fats in shift workers' diet suggest that the diet in this group is more likely to be based on animal products (such as meats and derivatives, and animal fats) compared with that of day workers'. Interestingly, one experimental study has shown an increased preference for high-fat foods but similar energy intake after one night of a simulated night shift, suggesting an increased preference for fat-rich foods after night shifts [14].

The diminished diet quality we observed in shift workers supports these assumptions, particularly for a reduced quality score for vegetable, total fat, and saturated fat intake. A previous report in Chilean adults showed that the overall diet quality was fairly poor (mean HEI 56.2 ± 11.1 points, of a maximum of 100), with 64.2% in need of changes and 34.6% being unhealthy [9]. The results we found in our study agree with that report. The overall HEI for the whole sample was 60.6%, and the HEI score in shift workers (56.2 ± 5.4 %) was quite similar to that report and significantly lower than that in the day-workers group (65.11 ± 9.1 %). As a whole, our results suggest a poor overall diet quality in this sample of shift workers, further diminished in shift workers.

Our findings point out the fact that shift workers would be less likely to achieve recommendations for a healthy diet, with diet being less healthy, an aspect that has been reported previously [12]. The reduced quality scores for vegetable, total fat, and saturated fat intake suggest that the diet of shift workers is insufficient regarding vegetable intake but also being excessive regarding total fat and saturated fat intake, distancing from healthy dietary advice. Further studies focused on the type of foods and macronutrient preferences are necessary to evaluate the impact of shift work on food intake and nutritional choices.

In Chile, a notable increase in the national prevalence of metabolic risk factors and chronic diseases such as type 2 diabetes, arterial hypertension, and obesity has been reported [15]. The figures we noted in our sample of healthcare workers with overweight and obesity close to 65% and 30%, respectively, are in line with those recently reported for the adult Chilean population. The epidemiological change is related to overall changes in Chilean dietary pattern, characterized by increased energy intake, with high total fat and saturated fat intake.

The aforementioned dietary changes can also be expected to be found in shift workers. As this is the first study conducted assessing dietary patterns in Chilean health workers, findings suggest that further diet characteristics could be impaired in this group. Our findings of delayed timing of late afternoon meals, frequent meals skipping, snacking behavior, and nighttime eating are in line with others [3,4,11]. Given that meal timing plays a role as or more important than the total calorie count for metabolic consequences [16], further interventions modulating eating patterns could be highly relevant to improve the metabolic health of shift workers [4]. Results of our study also agree with a recent report showing an irregular eating pattern in shift workers when working the night shift, with frequent snacking behavior compared with that in day shifts or days off, interrupting the normal nighttime fasting period [4].

Our findings of similar physical activity and daytime sleepiness levels between groups suggest that other factors may similarly influence both behaviors. A similar total physical activity with higher sedentariness has been reported in shift workers [17]. The fact that 86.7% of Chilean adults are sedentary [15] and the high prevalence of obesity (close 30% in our sample) closely associated with poor population's dietary habits [15] could relate to the absence of differences we found.

As limitations of our study, we would like to point out that we studied a small sample of healthcare workers and coming from only one hospital belonging to the Chilean public health system. Diet was evaluated through a 24-hour recall questionnaire, and we did not assess sleep characteristics in this sample of health workers. As for strengths, we would like to mention that dietary patterns, diet quality, and meal timing were well characterized. Further intervention studies are urgently needed aiming at strategic health preventive actions in Chilean shift workers. Our current results will be useful for strategies modulating meal timing, physical activity, and sleep patterns aimed to improve metabolic and circadian health in this population group.

In summary, the eating pattern is disturbed in this sample of Chilean healthcare shift workers. Those changes may contribute to

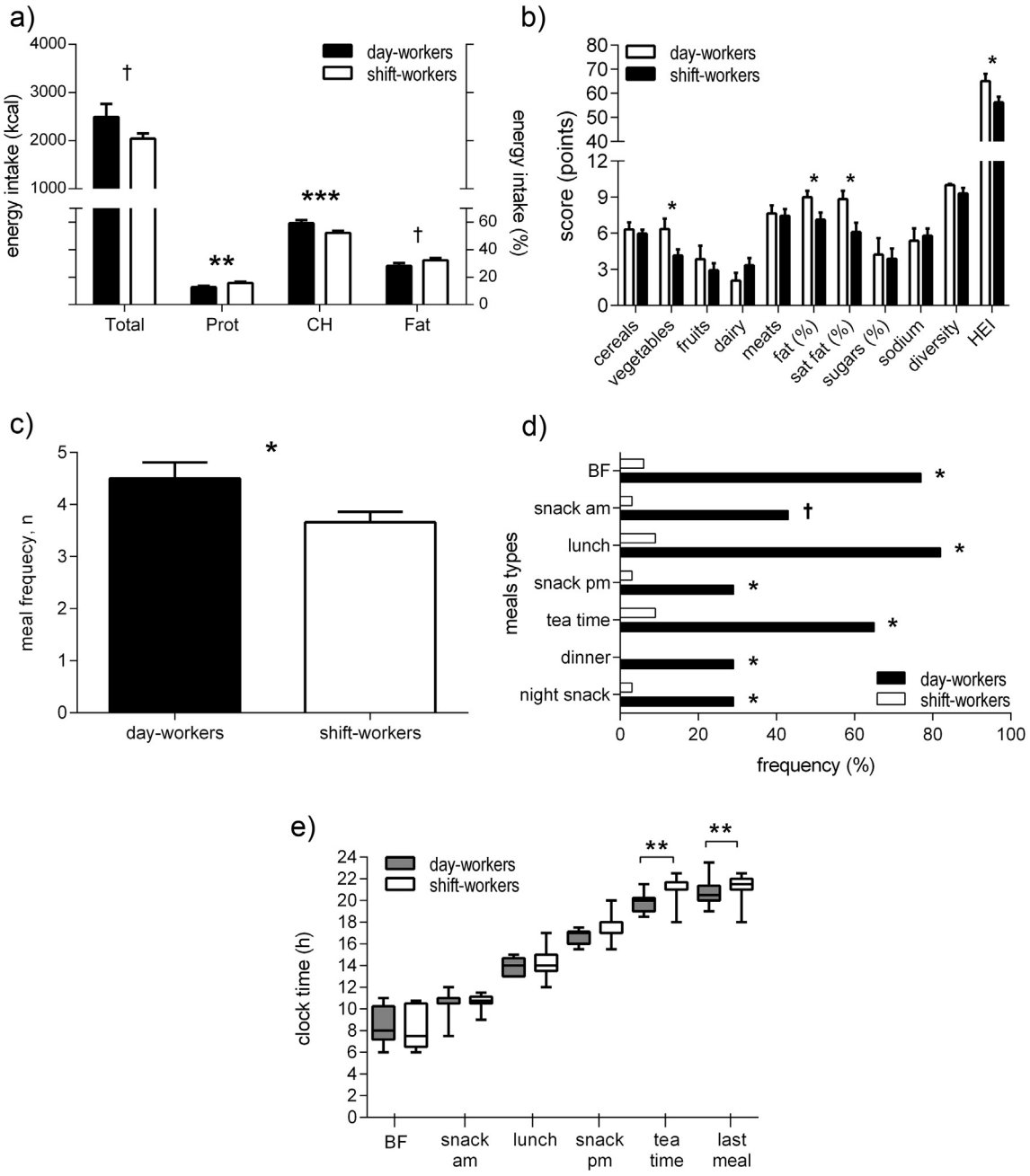

Fig. 1. Diet characteristics, meal frequency, and timing. Daily energy and macronutrient (%) intake (a) and diet quality scores (b), meal frequency (c), meal skipping (d), and meal timing (e). In (a), * total energy intake (kcal/day) and percentage of total energy intake coming from protein, carbohydrates, and fats; $^{**}P = 0.01$; $^{***}P = 0.007$; $\dagger P = 0.07$. In (b), the diet quality index evaluated the compliance with daily recommended consumption of food groups (portions/day) of cereals, vegetables, fruits, dairy products, and meats, as components of a healthy diet; day); total fat intake (% of energy), saturated fat (% of energy), sugars (% of energy), sodium (g/day), and the diversity of the diet (based on compliance above or below 25% of the recommended portions of the five analyzed food groups) were component also included in the HEI; data as mean ± SEM, *all $P < 0.05$. In (c), meal frequency on long workdays ('long shift', from 8 am to 8 pm), data as mean ± SEM, $^{*}P = 0{,}030$. In (d), meals on long workdays ("long shift", from 8 am to 8 pm), data as frequency (%) within each group, $^{*}P < 0.006$, $\dagger P = 0.07$. In (e), median onset time of main meals across the day. Data as median (middle line), p25 and p75 (box limits), minimum and maximum (whiskers), $^{**}P = 0.01$. Prot: proteins; CH: carbohydrates; HEI: healthy eating index; BF: breakfast; last meal: last (clock time) meal made taken at any time after teatime.

circadian and metabolic dysregulation in this group. As this is the first study evaluating these outcomes in this group, results highlight an urgent need for interventions modulating meal timing and diet quality in Chilean healthcare shift workers.

Disclaimers

This work was supported by the Dr. Exequiel González Cortés Hospital, Santiago, Chile.

Conflicts of interest

All authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.shaw.2020.07.002.

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