

Relationship between shift work and obesity; a retrospective cohort study

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Abstract

Aims: Obesity (OB) is one of the health problems that may lead other diseases. Many risk factors make OB that one of them is working on Shift Work (SW). In the present research, we are going to study the relationship between SW and OB by controlling confounding factor and with use of multilevel modeling, the powerful method for modeling correlated and longitudinal data.

Methods: The data were extracted is annual observation from workers who worked at Isfahan's Mobarakeh Steel Factory (ISCF) that collected in health and safety executive between 2001 until 2010 for longitudinal study. In this research we study the effect of SW on OB with controlling blood pressure, age, and education level. MLwiN programmer version 2.1 was used to apply a multilevel modeling.

Results: Total person who participate in this study was 6713 with 7 repetitions and range 10. The 45.2%, 6%, 48.8% of participation were day worker, weekly shift worker and routine shift worker respectively. In this study with controlling confounding factor working on SW was shown significance relationship with OB ($p=0.005$) and more result shown decreasing BMI in routine shift worker rather than day worker.

Conclusion: Since in most studies SW Mentioned as increasing factor for OB it can be something of a pattern in how the work schedule, pay and bonuses as a suitable model of ISCF can be used to reduce the effect on OB on SW.

Keywords: Body Mass Index, Longitudinal Study, Multilevel Modeling, Shift Work, Steel Factory, Cohort Study

Introduction

Shift Work (SW), which is recognized by some as working in the hours outside the normal daily working hours and by some others as working over the 7 A.M. to 7 P.M. working hours [1, 2], is among the social phenomena which is an inseparable part of providing services [3]. This leads to various diseases such as high blood pressure [4, 5, 6, 7], strokes [8], metabolic syndrome [9, 10, 11, 12], sleep disorders [13], diabetes [14, 15], Lipid disorders [16, 17], metabolic disorders [9, 13, 18], mental and psychological effects [19, 20] and the rise in Obesity (OB) and other diseases [21]. Most researches done on the relation between SW and OB have been accomplished to confirm the hypothesis of the rise in OB of shift works in proportion with the work days. Some examples are: *Ishizaki* et al. study [22], *Di Lorenzo* et al. [23], *Zhao* et al. [24], *Croce* et al. [25], *Antunes* et al. [26], and *Di Milia* et al. [27]. *Parkes* et al. showed in their studies that for those working at day or night, Body Mass

Index (BMI) rises more in comparison with day-working shift works [28]. Also, *Carlson* et al. concluded in a cross-sectional study that work shifts can lead to rise in BMI and disorder in Lipid serum [17]. *Antunes* et al. reviewing study also showed that OB and overweight have more frequency in shift workers in comparison with day workers [29]. The existence of an increase relation between SW and OB has been observed in longitudinal studies. Examples of this are: *Niedhammer* et al. longitudinal study [30], *Biggi* et al. longitudinal study [9], *Suwazono* et al. fourteen-year retrospective cohort study [31], or *Morikawa* et al. ten-year retrospective study [32]. Also, on the contrary of previous researches *Dochi* et al. realized in a fourteenth-month retrospective cohort study, which was done with aim of investigating hyper-cholesterol among shift workers as the secondary objective of their study, that shift workers have less BMI than day workers [33]. In *Ha* et al. cross-sectional study [34] and also in *De Assis* et al. cross-sectional study which was done in three working

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shifts of morning, afternoon and night, there was no significant statistical difference between BMI and shift work [35].

With respect to what is stated and also the existence of controversial studies in this regard, this study was done with the aim of investigating the effect of SW on individuals' OB with the adjustment of the majority of blood pressure, age and education level variables.

Methods

This research is retrospective and longitudinal study. The study population is consisted of all the crew working at Isfahan's Mobarakeh Steel Factory during the years of 2001 to 2010, amounting 6713 individuals. The data required was extracted by referring to the crew's medical files and in a census method. The criteria for entering the study were the individual's official or non-official enrolment during the years of 2001 to 2010, and the non-existence of specific disease in medical profile and being unretired, alive and not being expelled.

With respect to the legal obligation which forced the crew to do annual medicine inspections and refer daily to this section, there were no impositions from the researchers in this regard. Also, there was no obligation or punishment for non-entrance or non-referring concerning the sample under investigation and all participants attended the study with entire consent and the principle of confidentiality of the patients was observed as well. Eventually, after collecting data, analysis was done in a general manner and not individually.

The variable of SW was defined at three levels of routine SW, weekly SW and day work. Individuals in routine SW were 2 days morning at work, 2 days afternoon at work, 2 days night at work and 2 days off. In weekly SW, individuals were 3 days morning at work, 3 days afternoon at work, and were alternatively 1 day off within a 2 week-long work. Weekly shift workers were always off on Fridays. Day workers were at work from Saturday to Wednesday from morning to afternoon and were off on Thursdays and Fridays.

Individuals' blood pressure in sitting posture was measured from the two arms and was calibrated, using mercury blood pressure machine, after at least 5 minutes of relaxation and then was measured with respect to the details of British Hypertension society (BHS-IV) [36]. Also, height and weight were measured by a physicist, using scales and calibrated tools [37].

To investigate the effects of SW on OB, the multi-level analysis model was used which is a useful method for analyzing correlated and longitudinal data (when the environment, as a parameter, plays a confounding role) [38, 39]. The statistical equation intended for fitting data was like a multiple regression equation, while differing in that at the right-hand of this equation were added to independent variables, two random effects (environment and individual's effect), in addition to effects of random error along with independent variables. It was hypothesized in this statistical equation that the environment and individual random effects and error effects have respectively normal distribution with a mean of zero and variances σ_v^2 , σ_u^2 , σ_e^2 and distribution of random error was independent from two random effects of environment and individual. In this study, to fit the model, RIGLS method was used in which the estimation of random and fixed effects of model was calculated based on an iterative method [38]. Also, to analyze the data, SPSS 18 and MLwiN 2.1 software were used.

Results

The sample was 6713 individuals with the average repetition of 7 and range repetition of 10. The overall number of areas considered in this factory was 422. 3034 individuals (45.2%) of those sampled were day workers, 403 individuals (6%) were weekly shift workers and 3276 individuals (48.8%) were routine shift workers. In terms of education level, 1249 individuals (18.6%) of those sample were below diploma, 3974 individuals (59.2%) were holding diploma, 604 individuals (0.9%) were having associate degree and 886 individuals (13.2%) were having bachelor and postgraduate degrees. 315 individuals (4.7%) were under 25 years of age, 3263 individuals (48.6%) were between 26 and 40 years of age, and 3135 individuals (46.7%) were over 40 years and in terms of obesity, 74 individuals (1.1%) were low weight, 2954 individuals (44%) had healthy weight, 3175 individuals (47.3%) were overweight, 490 individuals (7.3%) were obese and 20 individuals (0.3%) had morbid obesity. Individuals' relative and absolute frequency in terms of education level is provided in Table 1, separated on the basis of SW.

The groups of routine SW, day work and weekly SW showed the most volume of blood pressure (systolic and diastolic), age and BMI respectively (Table 2). In terms of distribution extent, these variables were similar to each other in three groups.

Table 1- Relative and absolute frequency of the individuals under investigation in terms of education level separated on the basis of shift work

Education level → Shift work ↓	Below diploma	Diploma	Associate degree	Bachelor and above
Routine	3 (0.2%)	74 (5.9%)	867 (69.4%)	306 (24.5%)
Weekly	0 (0%)	187 (4.7%)	2671 (67.2%)	1117 (28%)
Day work	175 (29%)	78 (12.9%)	285 (47.2%)	66 (10.9%)
Total	1250 (18.6%)	3975 (59.2%)	604 (9%)	883 (13.2%)

In all cases were $p < 0.001$

By controlling confounding factors, shift work showed a significant relation with obesity.

Weekly shift workers were having lower BMI index (-0.781) than those of day workers and despite the positive Beta coefficient of regression equation (0.18) in routine shift workers in comparison with day workers, with respect to the reported amount of P ($p=0.269$), this increase was not confirmed statistically (Table 3).

Table 2- Mean and standard deviation of blood pressure, BMI and age variables separated on the basis of shift work

Index → Shift work ↓	Blood pressure (mmHg)		BMI (kg/m ²)	Age (year)	Number of repetition
	Systolic	Diastolic			
Routine	120.07±11.39	76.02±8.45	25.92±3.36	44.54±4.61	6.79
Weekly	118.59±11.28	74.73±8.42	24.59±3.02	41.98±3.97	7.75
Day work	119.11±10.72	74.99±7.79	25.66±2.99	42.13±4.01	6.75
Total	119.6±11.15	75.53±8.22	25.72±3.22	43.45±4.52	6.83

The significance level for all variables was $p < 0.001$

Table 3- The briefs of the results of three-level model for BMI variable, controlling confounding variables of age, blood pressure and education level

Variable	Beta	Se	P value
Shift work	-	-	0.005
Routine	0.180	0.163	0.269
Weekly	-0.781	0.292	0.007
Day work	It was taken as the reference level		

Discussion

Today, OB is one of health problems and more than 300 million individuals are inflicted with it worldwide [40]. On the other side, SW is one of modern phenomena, which is an indispensable part of service provision in many areas of industrial, economic and service activities [3] and large number of workers are involved with this. For example, in 2008, only in England there were more than 3.5 million individuals working as shift workers [41]. Hence, we embarked on the investigation of the effects of SW on OB in the form of a longitudinal research, due to the importance of work's role in SW. In this study, the variable of SW by controlling confounding factors such as age, blood pressure and education level showed relation with BMI and weekly shift workers were having lower BMI index (-0.781) in comparison with day workers. In this regard, the results of this study were similar to those of *Dochi et al.* [33].

Although the findings of the present research was not in harmony with the findings of some of researches [22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32], in this study like some other researches [34, 35], no statistical significant difference was observed between BMI index of routine shift workers and those of day

workers. This lack of relation can be assigned to fact that principally, healthier individuals are shift workers and weaker individuals are day workers. Also, most day workers are employed in clerical jobs whose main characteristic is sedentariness and the rise in OB; hence, this has caused to neutralize the effects of rise in OB with the increasing work effects in SW. But it should be said that since the extent of effect of SW on individuals depends generally on the individual's job, personal characteristics, societal and organizational environment and the features of their SW plans [42], therefore, this lack of relation can be ascribed to other factors such as shift workers enjoying variety in work period, income and the more relaxation time in comparison with day workers. Furthermore, there is no single definition of SW in all studies [43], and in addition to these, the kind of turn-taking in shift workers is different from each other. Also, in many researches, a variety of different jobs was investigated and eventually, in many researches, confounding variables, which affect OB such as lifestyle, physical activity, number of cigarettes, etc., have not been controlled in a certain extent [44].

The longitudinal nature of this research, the use of multilevel model in fitting data, the use of appropriate sample size, the homogenization of the individuals under investigation, and the calculation of individuals' BMI indexes (measuring weight and height) by specialists are among the strength of this study. But lack of the work experience variable in SW and also the non-access to the variables of kinship experience of blood pressure in close relatives and the inability to measure the sleep level and the income rate, the individual's job satisfaction, and the kind of the crew's

coming and going to the workplace, as confounding factors, can be regarded as the weaknesses of this study. Also, because in this study, it was not possible to access the information concerning the beginnings of the employment, the calculation of BMI changes was not possible during the study's time period. Thus, in this research, only longitudinal changes of this index were calculated which was, in itself, one of our research's limitations.

To observe the more exact effect of work in SW on OB, the accomplishment of other researches is proposed while controlling confounding variables such as work experience, family experience and psychological factors such as job stress, job satisfaction, etc.

Conclusion

SW variable by controlling confounding factors such as age, blood pressure and education level show relation with BMI. Weekly shift workers have lower BMI index than those of day workers. Also, there was no significant statistical difference between BMI index of routine shift workers and those of day workers. The lack of this relation can be ascribed to the possibility of shift workers being healthier, the weekly shift workers' enjoyment of variety in work period, income and more relaxation time in comparison with those of day workers.

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