Original

Psychosocial work environment and oxidative stress among nurses'

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Abstract: Background: Work stress among nurses has increased in recent years due to the demands of clinical nursing. **Objectives:** To investigate psychosocial work stress among nurses using the effort-reward imbalance (ERI) model with assessment malondialdehyde (MDA) as an oxidative stress marker and total antioxidants. **Methods:** The present study was conducted on 204 registered nurses worked at two tertiary hospitals in Menoufia governorate, Egypt through the period from the 1st of February to the end of July 2016. Two questionnaires were applied including general demographic and occupational histories as well as effort-reward questionnaire. Blood analysis was performed to assess MDA and total antioxidant levels. **Results:** ERI was prevalent among the study participants (72.5%). ERI was more prevalent among young married nurses who worked more than 10 years. Nurses that worked at ICUs complained more of ERI (43.2%) while nurses that worked at operation rooms complained more of overcommitment (62.5%). MDA levels were significantly positively correlated with E/R ratios (rho = 0.350, P ≤ 0.001). **Conclusions:** Work stress was prevalent among the studied nurses as revealed by the high ERI and MDA levels. Young married female nurses complained more of work stress. ICUs and operating rooms were the most stressful departments at the studied hospitals. Hence, implementing programs and strategies that eliminate stressful working conditions at hospitals is critical to the reduction and prevention of work stress among nurses.
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1. Introduction

Nursing staff is exposed to high physical and psychosocial work load. Patients' needs and safety, long shifts, work overload, work-related conflicts, shortage of staff, conflicts with supervisors, bias, and lack of organizational support are stressful factors in nursing jobs[1,2] that might be associated with increased levels of sickness, absence, high rate of staff turnover, burnout, and poorer physical and psychological health[3]. Moreover, stressful nursing is likely to affect the provision of care and treatment outcomes[4].

The effort-reward imbalance (ERI) model is a theoretical concept proposed by Siegrst[5] validated approach to measure chronic psychosocial work stress by identifying non-reciprocity between the occupational efforts and rewards that has been found to predict poor health[6].

Moreover, the ERI model includes an overcommitment scale that depends on personality characteristics, including attitudes, behaviors Moreover, and emotions that reflect excessive work effort combined with a strong desire for approval[7]. Overcommitment has been found to be associated with insomnia[8], poor self-rated health[9], and emotional exhaustion at work[10]. The ERI model is popular in stress-related research because it consists of both situational and personal stressors' characteristics[11].

Stressful conditions, including occupational stress, lead to the excessive formation of free radicals or reactive oxygen species and cause oxidative stress[12]. Free radicals are formed in the human body in the cytosol, mitochondria, lysosomes, peroxisomes, and plasma membranes under both physiological and pathological conditions. They initiate a cascade, causing lipid peroxidation that directly damages biological membranes and generates a number of secondary products, including aldehydes such as ma-

londialdehyde (MDA), which is the most abundant aldehyde resulting from lipid peroxidation[13].

The human body have an integrated antioxidant system that includes enzymatic and nonenzymatic antioxidants that are usually effective in blocking the harmful effects of free radicals. Once the balance between free radicals production and the antioxidative defense activity is disrupted, oxidative stress can occur, which may result in cell injury or death, and subsequent damage and, finally, chronic disease[14].

Many biomarkers of oxidative damage are labor- and time-intensive and may not be appropriate for use in epidemiologic studies or clinical trials involving hundreds or thousands of subjects. On the other hand, MDA is a widely used, sensitive, and appropriate oxidative biomarker[15].

Previous studies found an association between elevated MDA levels and occupational stress, such as the study carried out by Casado et al.[12], who reported a positive correlation between MDA and occupational stress in workers of a prehospital emergency service. Tsuboi et al.[16] also found a correlation between elevated MDA levels and depressive symptoms in nurses who complained of low job stress.

There are few studies on the psychosocial factors at work places in Egypt. The present study aimed to investigate the psychosocial work stress among nurses defined by the ERI model with assessment of MDA as an oxidative stress marker and total antioxidants.

2. Participants and Methods

2.1 Design and sample

This was a cross sectional study conducted at two tertiary hospitals, the Menoufia University Hospital and the Psychiatric and Addiction Treatment Hospital at the Menoufia governorate, Egypt. Data collection was conducted from February 1 to the end of July 2016.

All the nursing staff that worked in the two studied hospitals (257 nurses) were targeted to the study. Twenty four nurses were excluded firstly as they had one or more items of the exclusion criteria of the study that included recent acute infectious illness, chronic diseases (of liver, kidney, diabetes mellitus), malignancy, smoking, pregnancy and psychiatric disorders. The remaining 233 nurses were invited to participate in this study but 29 disagreed to participate. The final sample size of this study was 204 participants, with a response rate of approximately 87.6% (204/233). The participants were distributed over all hospitals' departments including operating rooms (at General and Special Surgeries), Intensive Care Units (medical and surgical), and other departments (Internal Medicine, Psychiatric and Pediatric departments).

2.2 Measures

All the participants were interviewed by the authors after the work shift at the administration departments of the studied hospitals and subjected to the following:

2.2.1 Structured interview questionnaire

This tool was developed and used by the researchers based on the review of the relevant literature. It included socio-demographic data (age, gender, education levels, marital status) and occupational history (jobs titles, hospital unit, duration of work, and shift work system).

A pilot study was carried out in 10 subjects that were excluded from the study sample to test feasibility and applicability of the questionnaire, and modifications were done accordingly.

2.2.2 Effort-Reward Imbalance (ERI) model to assess work stress

ERI is one of the worldwide models to assess work stress. It was originally developed by Siegrist et al.[17]. The model reflects the non-reciprocity of social exchange (i.e., high effort/low reward at work) which leads to a state of emotional distress. In addition, the model includes a pattern of coping with job demands, which is known as overcommitment. The ERI model consisted of 23 items divided into three components: effort (6 items), reward (11 items), and overcommitment (6 items). The effort component included physical load, time pressure, interruptions, responsibilities, working overtime, and increasing demands at work. The reward component consisted of financial, esteem, promotion and job security factors[18].

The Arabic-translated version of the ERI questionnaire was applied in this study[19]. Items on the effort scale were answered using a 5-point rating scale (1: disagree; 2: I am not at all distressed; 3: I am somewhat distressed; 4: I am distressed; and 5: I am very distressed), with higher scores indicating higher effort at work. The 11 items measuring reward were framed similarly, but the coding was reversed so that a lower summary score for reward indicates a higher subjective rate of distress due to low reward[19]. The overall ERI score was calculated as effort divided by reward with a correction factor for the different number of items in each scale: E/R ratio = (effort score/ reward score × 1.834); a score of one or less represents a balance between effort and reward, whereas scores above one reflect a perceived disproportionate effort and stress[17].

In addition, the overcommitment scale included esteem, promotion, and security subscales that were measured by six questions scored using a 4-point scale (1: strongly disagree; 2: disagree; 3: agree; 4: strongly agree) with a total score ranging from 0-24. A high overcommitment score was indicated by a total score in the upper tertile of the total score[20].

In this study, Cronbach's alpha values of the ERI model were 0.83 for effort, 0.87 for reward, and 0.75 for overcommitment.

2.2.3 Biochemical analysis

About 10 m*l* of blood was drawn from each participant using a 19-gauge butterfly needle connected to a plastic syringe. Then the content of the syringe was transferred immediately to polypropylene tubes, which were then centrifuged at 3,000 rpm for 10 minutes at 10-18℃. The serum supernatant samples were stored in plastic tubes at −80℃ until assayed. The following serum markers were assessed:

Total antioxidant capacity was measured by colorimetry, Biodiagnostic Kit. Egypt. The principle depends on Cu^{2+} ion is converted to Cu+ by both small molecule and protein. The Protein Mask prevents Cu^{2+} reduction by protein, enabling the analysis of only the small molecule antioxidants. The reduced Cu^{+} ion is chelated with a colorimetric probe, giving a broad absorbance peak around 570 nm, which is proportional to the total antioxidant capacity[21].

MDA levels were determined through a spectrophotometrical method. The principle depends on the reaction of thiobarbituric acid with MDA in acidic medium at a temperature of 95℃ for 30 minutes to form thiobarbituric acid reactive product; the absorbance of the resultant pink product can be measured at 534 nm[22].

The biochemical analysis was performed at the central laboratory of the Menoufia University Hospital.

2.3 Ethical considerations

The Menoufia Faculty of Medicine Committee for Medical Research Ethics reviewed and formally approved the study before its beginning. Informed formal consent was obtained from each participant prior to the beginning of the study. All subjects involved in the study received detailed information concerning the aims of the research study. Also, an official approval was obtained by the researchers from the administrators of the studied hospitals.

2.4 Statistical analysis

Results were collected, tabulated, statistically analyzed by IBM personal computer and statistical package SPSS version 20. Two types of statistic analyses were performed. Descriptive statistics: e.g., percentage (%), mean, and standard deviation (SD); and Analytic statistics: Mann-Whitney *U* test, which is a non-parametric test of significance used for comparison between two groups having quantitative variables not normally distributed, Kruskall-Wallis test, which is a non-parametric test of significance used for comparison between more than two groups having quantitative variables not normally distributed, and the Chi-squared (χ^2) test was used to study the association between two or more qualitative variables. Binary logistic regression analysis was performed to examine the independent effects of the marital status and the unit types on ERI. We adjusted for age, gender, education level, job titles, years of experience, and shift work. The results are shown as odds ratio (OR) and 95% confidence interval (CI). Spearman's rank correlation coefficient (rho) was used to study the association between E/R ratios, MDA, and total antioxidant levels in the ERI group. A P-value of <0.05 was considered statistically significant.

3. Results

Table 1 shows ERI and overcommitment in relation to characteristics of the studied participants. More than half (54.9%) of the studied group was 20-30 years old. The majority of the participants were females (94.1%) and married (92.2%). Secondary-educated nurses prevailed and were followed by those with university education (37.3% and 35.3%; respectively). Two thirds (66.7%) of the participants worked rotating shifts, including night shifts. About 47.1% of the participants worked for more than 10 years. The prevalence of work stress among the studied nurses (as revealed by ERI score of >1) was high (72.5%) while overcommitment was prevalent in about one third of them (31.4%). ERI was significantly predominant among lower aged (from 20-40 years), married, female nurses. In addition, nurses that worked in ICUs followed by nurses that worked in the operation rooms had significantly more ERI (43.2% and 32.4%; respectively). Moreover, ERI was significantly prevalent among those who worked for more than 10 years (51.4%), followed by those who worked less than 5 years (35.1%). Total antioxidant levels were significantly higher in the ERI group, but there was no significant correlation between these levels and the E/R ratios (rho = 0.01; P = 0.866, Fig. 1). High overcommitment scores were significantly predominant in nurses that worked in operating rooms (62.5%). Moreover, the MDA levels were significantly higher in the high overcommitment group than in the lower one.

Married nurses and working at operation rooms and ICUs were still significantly associated with ERI (OR = 8.09, 95% CI: 1.645-39.782; OR = 37.27, 95% CI: 8.172-169.967; and OR = 13.34, 95% CI: 3.821-46.589, respectively), as shown in Table 2.

The MDA levels were significantly elevated with age (>30 years). Also, there were significant differences in the MDA levels in the studied participants regarding the working departments; the highest levels were observed in nurses that worked in operation rooms (4.23±3.18), followed by those that worked in ICUs (3.03±1.47) than in other departments as shown in Table 3.

Although there was no significant increase in the levels of MDA in the ERI group (Table 2), these levels were significantly positively correlated with E/R ratios (rho = 0.350; P ≤ 0.001), as shown in Fig. 2.

Table 1. ERI and overcommitment in relation to characteristics of the studied participants

Characteristics	Total (n=204) No (%)	ERI			Overcommitment		
		≤ 1 (n=56) No (%)	>1 (n=148) No (%)	*P value	Low (n=140) No (%)	High (n=64) No (%)	*P value
Age (years):							
20-30	112 (54.9)	24 (42.9)	88 (59.5)	<0.001	76 (54.3)	36 (56.2)	0.846
>30-40	76 (37.3)	32 (57.1)	44 (29.7)		52 (37.1)	24 (37.5)	
>40	16 (7.8)	0	16 (10.8)		12 (8.6)	4 (6.2)	
Gender:							
Females	192 (94.1)	56 (100.0)	136 (94.1)	0.028	132 (94.3)	60 (93.8)	0.880
Males	12 (5.9)	0	12 (8.1)		8 (5.7)	4 (6.2)	
Education levels:							
Secondary school	76 (37.3)	20 (35.7)	56 (37.8)	0.313	52 (37.1)	24 (37.5)	0.630
University	72 (35.3)	24 (42.9)	48 (32.4)		52 (37.1)	20 (31.2)	
Technical Institute of nursing	56 (27.5)	12 (21.4)	44 (29.7)		36 (25.7)	20 (31.2)	
Marital status:							
Single	188 (92.2)	8 (14.3)	8 (5.4)	0.035	12 (8.6)	4 (6.2)	0.567
Married	16 (7.8)	48 (85.7)	140 (94.6)		128 (91.4)	60 (93.8)	
Job title:							
Nurse	136 (66.7)	32 (57.1)	104 (70.3)	0.076	88 (66.7)	48 (75.0)	0.088
Supervisor	68 (33.3)	24 (42.9)	44 (29.7)		68 (33.3)	16 (25.0)	
Unit type:							
ICUs	76 (37.3)	12 (21.4)	64 (43.2)	<0.001	56 (40.0)	20 (31.2)	<0.001
Operating rooms	60 (29.4)	12 (21.4)	48 (32.4)		20 (14.3)	40 (62.5)	
Other departments	68 (33.4)	32 (57.2)	36 (24.4)		60 (42.9)	4 (6.2)	
Years of experience:							
< 5	72 (35.3)	20 (35.7)	52 (35.1)	0.026	48 (34.3)	24 (37.5)	0.427
5-10	36 (17.6)	16 (28.6)	20 (13.5)		28 (20.0)	8 (12.5)	
>10	96 (47.1)	20 (35.7)	76 (51.4)		64 (45.7)	32 (50.0)	
Shift work:							
Day shift	68 (33.3)	20 (35.7)	48 (32.4)	0.657	48 (34.3)	20 (31.2)	0.670
Rotating shift	136 (66.7)	36 (64.3)	100 (67.6)		92 (65.7)	44 (68.8)	
Total antioxidant levels (nmol/*l*)							
Mean ± SD	0.59±0.33	0.52±0.21	0.62±0.36	0.014**	0.57±0.34	0.64±0.30	0.440**
MDA levels (umol/*l*):							
Mean ± SD	3.20±2.21	3.10±1.75	3.23±2.36	0.691**	2.12±1.41	3.60±2.32	<0.001**

*p value for χ^2 test
**: Mann-Whitney test was used

4. Discussion

The aim of this study was to determine the psychosocial work stress assessed by ERI mode and its association with oxidative stress parameters (MDA and antioxidants) in a sample of nurses. MDA levels were significantly positively correlated with E/R ratios. Moreover, MDA levels were significantly higher in nurses with high overcommitment, which is a coping mechanism to excessive work-related commitment. These findings suggested that nurses working in a desynchronized environment might be less able to cope with the negative effects of the ERI model and might be under stress[23]. This is consistent with the research by Tsuboi et al.[16], who reported a positive correlation between elevated MDA levels and depressive symptoms in nurses that complained of job stress. Also, the association between psychiatric disorders and increased MDA levels was found by Khanzode et al.[24] in patients with major depression.

Moreover, MDA levels in all the studied participants (3.20±2.21 μmol/*l*) might be more than four times higher
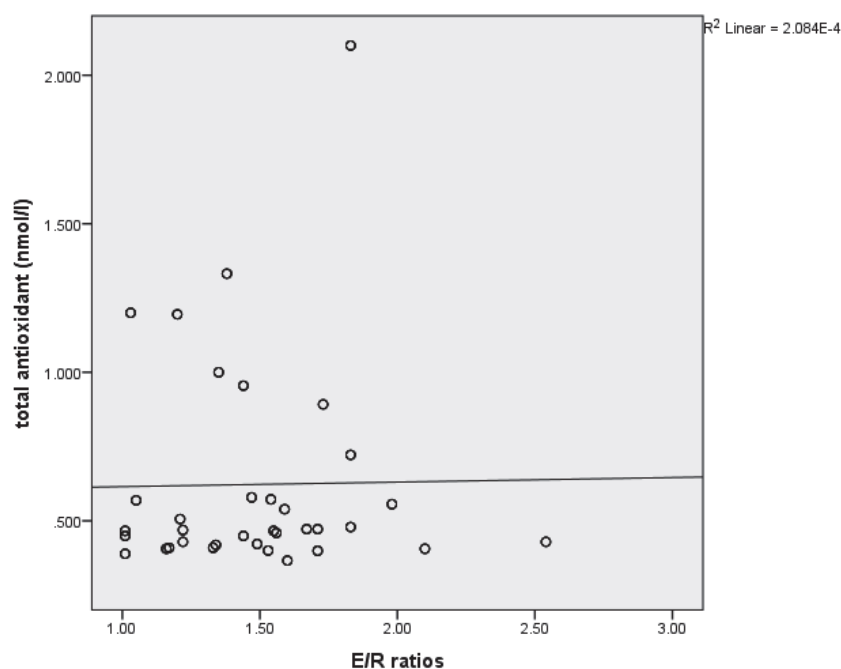
Fig. 1. Correlation between E/R ratio with total antioxidant levels in the studied participants

rho= 0.01 P=0.866

than the normal value for MDA, which is less than 0.7 $\mu mol///l$[25]. These finding show that the oxidative stress among nurses may be much higher than that of general population.

Three hypothesis related to the ERI model were postulated[20]: the extrinsic hypothesis suggested that high effort and low reward lead to strain and health effects; the intrinsic hypothesis stated that overcommitment was responsible for the development of strain and the negative health effects; and the intrinsic interaction hypothesis, which stated that the negative effect of ERI was exaggerated by overcommitment. Our findings might support the intrinsic hypothesis as revealed by the significant higher MDA levels in nurses with high overcommitment.

Research evidence for the role played by overcommitment in predicting strain is, however, mixed and inconclusive. Several studies provided evidence for the intrinsic overcommitment hypothesis, whereby employees who are more overcommitted tend to report poorer physical and psychological health[20,26,27], but other studies fail to find support this prediction[28-30].

Overcommitment was considered as a predictor of ERI by some researchers as highly overcommitted employees tend to invest much effort in their work over the appropriate levels and judge their extrinsic rewards to be low as a result, they perceive ERI[31]. Accordingly, the MDA might reach significant levels in the ERI group with prolonged overcommitment, especially as MDA levels were positively correlated with E/R ratios.

Overall, 72.5% and 31.4% of the nurses reported having experienced ERI and over-commitment, respectively. This high prevalence of ERI and overcommitment may be the result of the overburdened health care system in Egypt, understaffing among the nursing staff, lack of resources, inadequate salaries, difficult work schedules, inadequate security, and poor career advancement[32]. Moreover, Chandola el al.[33] reported that the imbalance between the efforts spent and the rewards received is likely to be experienced by employees who have little choice of alternative workplaces or who accept this imbalance for improvement of their future chances in addition to, if employees exhibit overcommitment. Therefore, this stressful working environment needs improvement and promotion.

The prevalence of ERI and overcommitment experienced by nurses in the current study were different from those of studies performed in other countries. For example, Sakata et al.[34] reported that 12.2% and 44.4% of the medical residents in Japan experienced ERI and overcommitment, whereas Conway et al.[35] reported that 16.1% and 26.3% of the health care workers in Italy experienced ERI and overcommitment. A survey on a group of nurses in the ORSOSA study in France identified ERI in 10.7% of the nurses and overcommitment in 40.8% of the nurses[36]. In the current study, nurses had a higher prevalence of ERI. This difference might be explained by the variations in culture and nature of the health system, including structural and service delivery problems in different countries[37].

High ERI in the present study was predominant among nurses aged 20-30 years. Younger nurses were more en-

Table 2. Binary logistic regression analysis for covariates of ERI in the studied participants

	OR (95% CI)	P value
Age (years):		
20-30	1.34 (0.84-2.14)	0.607
>30-40	0.91 (0.53-1.67)	0.998
>40	1.00 (reference)	
Gender:		
Females	0.88 (0.55-1.42)	0.995
Males	1.00 (reference)	
Education levels:		
Secondary school	0.31 (0.070-1.370)	0.123
University	0.94 (0.097-3.036)	0.956
Technical Institute of nursing	1.00 (reference)	
Marital status:		
Single	1.00 (reference)	
Married	8.09 (1.645-39.782)	0.031
Job title:		
Nurse	1.84 (0.195-2.357)	0.595
Supervisor	1.00 (reference)	
Unit type:		
Other departments	1.00 (reference)	
ICUs	13.34 (3.821-46.589)	<0.001
Operating rooms	37.27 (8.172-169.967)	<0.001
Years of experience:		
< 5	1.00 (reference)	
5-10	1.29 (0.244-6.790)	0.767
>10	1.17 (0.638-2.115)	0.997
Shift work:		
Day shift	1.00 (reference)	
Rotating shift	0.82 (0.274-2.440)	0.718

Adjusted for age, gender, education levels, job titles, years of experience and shift work OR, Odds ratio; CI, confidence interval.

gaged in work duties and this might expose them to more work stress. This result was coincided with that of a previous Egyptian study conducted by Arafa et al.[38]. Also, Wisetborisut et al.[39] found that older workers reported less burnout than younger ones and that this may result from a longitudinal developmental process that helps over time to protect them from psychological distress and burnout.

About half of the nurses who experienced ERI in this study were employed for more than ten years. As nurses with more years of experience have more responsibility and expect more reward at work place. This result coincided with that of Lee et al.[40], who revealed that public health nurses of younger age and longer past clinical experience perceived more occupational stress. On the contrary, Dagget et al.[41] found no variation in job-related stress and length of service in Ethiopian nurses, but they applied different tools in the assessment of job stress.

Of the covariates analyzed in this study, ERI in nurses was significantly different among nurses who worked in different hospital units. ERI was more common in nurses who worked in operating rooms than in those who worked in other departments. The operating room is a complex, stressful, and potentially hazardous environment. Moreover, nurses in the operating room have to care for the patients' conditions, cooperate with the surgeon to perform difficult procedures, and share with the team dynamics and environmental conditions[42]. Kawano[43] reported that the operating room nurses developed fatigue independently of demographic or job-related stress factors.

Overcommitment was significantly experienced by nurses who worked in ICUs than by those who worked in other departments. Nurses who worked in ICUs mainly care for critical cases and patients at high risk of death; therefore, they were exposed to higher work load and

Table 3. MDA levels in relation to characteristics of the studied participants

Characteristics	MDA levels (umol/*l*) Mean ± SD	Test of significance	P value
Age (years):			
20-30	2.76 ±1.87	Kruskall-Wallis test=9.36	0.009
>30-40	3.88 ±2.64		
>40	3.06 ±0.92		
Gender:			
Females	3.09 ±2.13	Mann-Whitney test=1.50	0.133
Males	7.78 ±2.90		
Education levels:			
Secondary school	3.47±2.71	Kruskall-Wallis test=0.121	0.941
University	3.01±1.96		
Technical Institute of nursing	3.10±1.79		
Marital status:			
Single	3.47 ±1.44	Mann-Whitney test=1.43	0.153
Married	3.18 ±2.27		
Job title:			
Nurse	3.26 ±2.36	Mann-Whitney test=0.11	0.912
Supervisor	3.07 ±1.88		
Unit type:			
ICUs	3.03 ±1.47	Kruskall-Wallis test=10.24	0.006
Operating rooms Other	4.23 ±3.18		
departments	2.59 ±1.64		
Years of experience:			
< 5	2.98 ±1.99	Kruskall-Wallis test=1.12	0.570
5-10	2.97 ±1.94		
>10	3.47 ±2.46		
Shift work:			
Day shift	3.30 ±2.45	Mann-Whitney test=0.20	0.843
Rotating shift	3.15 ±2.09		

work stress. In contrast, Lin et al.[23] found that overcommitment was more common in nurses who worked in acute wards than in those who worked in ICUs or emergency rooms, while Sakata et al.[34] found no significant differences in effort, reward, and overcommitment between specialties of Japanese medical residence.

In addition, MDA levels were significantly higher in participants aged 30-40 years and that worked in operation rooms and ICUs, which is in accordance with the results for overcommitment and ERI in the current study, reflecting the stressful environment of these units. This result coincided with that of Casado et al.[44] who observed significant higher levels of MDA in nurses aged 30-39 years and that worked in ICUs than in those of the control group.

Previous studies as that carried out by Block et al.[45] found a strong association between smoking and MDA levels. On the other hand, Ayaori et al.[46] did not find elevated MDA levels in smokers. We did not investigate the

effect of smoking in this study as it was put in the exclusion criteria of the studied participants. Also, the levels of serum MDA showed a statistically significant increase after Intense Exercise[47].

The levels of total antioxidants in this study were significantly higher among nurses with ERI. This might be a protective body response against work stress as the oxidative stress can be effectively neutralized by enhancing cellular defenses in the form of antioxidants[48]. Moreover, more than half of the participants with ERI were of younger age (20-30 years) and had a better antioxidants defense response. In addition, the antioxidant levels in the present study were not significantly correlated with E/R ratio, suggesting that these higher levels were not associated with ERI in the studied participants.

Also, the antioxidant enzymes, especially the inducible superoxide dismutase enzyme, have been shown to be elevated at risk of exposure to low doses of various stressors as found in cigarette smokers[49], asbestos-exposed
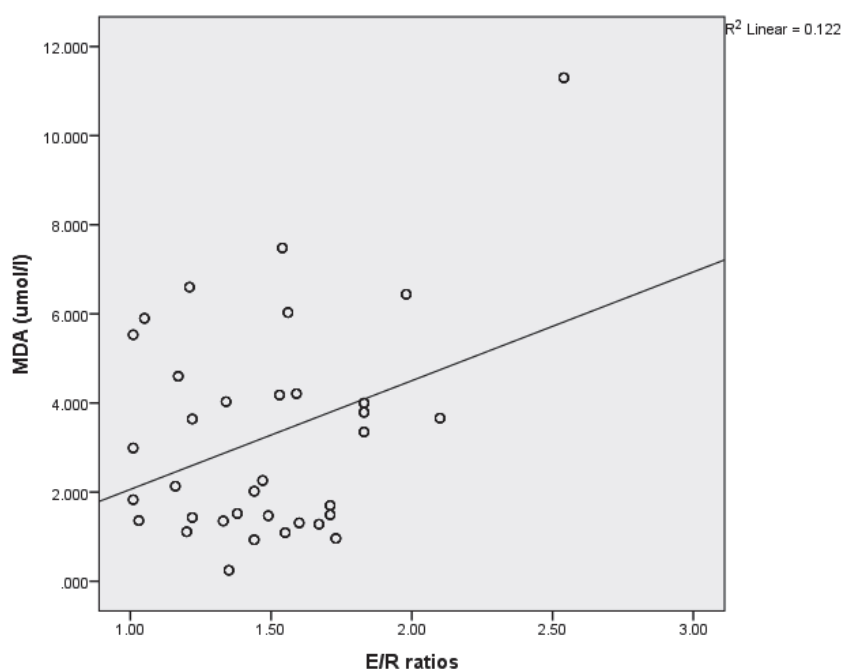
Fig. 2. Correlation between MDA levels and E/R ratios in the studied participants with ERI.
rho= 0.350 P=< 0.001

workers[50], ionizing radiation-exposed workers[51] and in athletes[52] who have higher antioxidants levels than controls.

This study had several limitations. First, it had a cross sectional study design, so we were unable to prove any chronobiological effects of work stressors and we can't derive any conclusions on the causality of ERI and oxidative stress in nurses. Second, the small sample size might limit the generalizability of this study. Despite these limitations, this study reflects the association between psychosocial work environment and oxidative stress in the nursing job. Therefore, these results should be verified with large-scale and multicenter studies.

5. Conclusion and Recommendations

In our study, we found that the psychosocial work environment may be associated with occupational stress among nurses, as revealed by ERI, overcommitment, and elevated MDA levels. However, this association may be improved through implementation of appropriate stress reduction interventions including education and practice changes at hospitals to help the nurses to cope with their job stressors.

References

1) Rodrigues V, Ferreira A. Stressors in nurses working in intensive care unit. Revista Latino-Americana de Enfermagem 2011; 19(4): 1025-1033.
2) Higazee M. Types and Levels of Conflicts Experienced by Nurses in the Hospital Settings. Health Science Journal 2015; 9(6): 1-7.
3) Van Vegchel N, de Jonge J, Meijer T, et al. Different effort constructs and effort-reward imbalance: effects on employee well-being in ancillary health care workers. Journal of Advanced Nursing 2001; 34(1): 128-136.
4) Aiken LH, Clarke SP, Sloane DM, et al. Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction. The Journal of the American Medical Association 2002; 288(16): 1987-1993.
5) Siegrist J. Adverse health effects of high-effort/low-reward conditions. Journal of Occupational Health Psychology 1996; 1(1): 27-41.
6) Weyers S, Peter R, Boggild H, et al. Psychosocial work stress is associated with poor self-rated health in Danish nurses: a test of the effort-reward imbalance model. Scandinavian Journal of Caring Sciences 2006; 20(1): 26-34.
7) Kikuchi Y, Nakaya M, Ikeda1 M, et al. Effort-reward imbalance and depressive state in nurses. Occupational Medicine 2010; 60(3): 231-233.
8) Ota A, Masue T, Yasuda N, et al. Psychological job characteristics and insomnia: A prospective cohort study using the demand-control-support (DCS) and effort-reward imbalance

(ERI) job stress models. Sleep Medicine 2009; 10(10): 11127.

9) Salavecz G, Chandola T, Pikhart H, et al. Work stress and health in western European and post-communist countries: An East-West Comparison study. Journal of Epidemiology & Community Health 2010; 64(01): 57-62.

10) Salmela-Aro K, Rantanen J, Hyvönen K, et al. Bergen Burnout Inventory: Reliability and validity among Finnish and Estonian managers. International Archives of Occupational and Environmental Health 2011; 84(6): 635-645.

11) Derycke H, Vlerick P, Burnay N, et al. Impact of the effort-reward imbalance model on intent to leave among Belgian health care workers: A prospective study. Journal of Occupational and Organizational Psychology 2010; 83(4): 879-893.

12) Casado A, de Lucas N, López-Fernández M, et al. Lipid peroxidation, occupational stress and aging in workers of a pre-hospital emergency service. European Journal of Emergency Medicine 2006; 133(3): 164-171.

13) Choi H, Kim J, Chang M, et al. Effects of astaxanthin on oxidative stress in overweight and obese adults. Phytotherapy Research 2011; 25(12): 1813-1818.

14) Ulas T, Buyukhatipoglu H, Kirhan I, et al. The effect of day and night shifts on oxidative stress and anxiety symptoms of the nurses. European Review for Medical and Pharmacological Sciences 2012; 16(5): 594-599.

15) Gladys B, Marion D, Edward P, et al. Factors Associated with Oxidative Stress in Human Populations. American Journal of Epidemiology 2002; 156(3): 274-285.

16) Tsuboi H, Tatsumi A, Yamamoto K, et al. Possible connections among job stress, depressive symptoms, lipid modulation and antioxidants. Journal of Affective Disorders 2006; 91(1): 63-70.

17) Siegrist J, Starke D, Chandola T, et al. The measurement of effort-reward imbalance at work: European comparisons. Social Science & Medicine 2004; 58(8): 1483-1499.

18) Li J, Yang W, Siegrist Y, Cho S. Effort-reward imbalance at work and job dissatisfaction in Chinese healthcare workers: a validation study. International Archives of Occupational and Environmental Health 2005; 78(3): 198-204.

19) Almadi T, Cathers I, Chow C. An Arabic version of the effort-reward imbalance questionnaire: translation and validation study. Psychological Reports 2013; 113(1): 1-16.

20) Van Vegchel N, De Jonge J, Bosma H, et al. Reviewing the effort-reward imbalance model: Drawing up the balance of 45 empirical studies. Social Science & Medicine 2005; 60(5): 1117-1131.

21) Koracevic D, Koracevic G, Djordjevic V, et al. Method for the measurement of antioxidant activity in human fluids. Journal of Clinical Pathology 2001; 54(5): 356-361.

22) Garcia Y, Rodriguez-Malaver A, Penaloza N. Lipid peroxidation measurement by thiobarbituric acid assay in rat cerebellar slices. Journal of neuroscience methods 2005; 144(1): 127-135.

23) Lin PC, Chen CH, Pan SM, et al. The association between rotating shift work and increased occupational stress in nurses. Journal of Occupational Health 2015; 57(4): 307-315.

24) Khanzode S, Dakhale G, Khanzode S, et al. Oxidative damage and major depression: the potential antioxidant action of selective serotonin re-uptake inhibitors. Redox Report 2003; 8(6): 365-370.

25) Casado A, de Lucas García N, López-Fernández M, et al. Antioxidant enzymes, occupational stress and burnout in workers of a prehospitalary emergency service. European Journal of Emergency Medicine 2005; 12(3): 111-115.

26) Fahlen G. Effort-reward imbalance, sleep disturbances and fatigue. International Archives of Occupational and Environmental Health 2006; 79(5): 371-378.

27) Niedhammer I. Psychosocial work environment and mental health: job-strain and effort-reward imbalance models in a context of major organisational changes. International Journal of Occupational and Environmental Health 2006; 12(2): 111-119.

28) Ertel M, Pech E, Ullsperger P, et al. Adverse psychosocial working conditions and subjective health in freelance media workers. Work and Stress 2005; 19(3): 293-299.

29) Hanebuth D, Meinel M, Fischer J. Health-related quality of life, psychosocial work conditions and absenteeism in an industrial sample of blue- and white-collar employees: a comparison of potential predictors. Occupational and Environmental Medicine 2006; 48(1): 28-37.

30) Kuper H, Singh-Manoux A, Siegrist J, et al. When reciprocity fails: effort-reward imbalance in relation to coronary heart disease and health functioning within the Whitehall II study. Occupational and Environmental Medicine 2002; 59(11): 777-784.

31) Feldt T, Hyvönen K, Mäkikangas A, et al. Overcommitment as a predictor of effort-reward imbalance: evidence from an 8-year follow-up study. Scandinavian Journal of Work, Environment & Health 2016; 42(4): 309-319.

32) Abdo S, El-Sallamy R, El-Sherbiny A, et al. Burnout among physicians and nursing staff working in the emergency hospital of Tanta University, Egypt. Eastern Mediterranean Health Journal 2015; 21(12): 906-905.

33) Chandola T, Siegrist J, Marmot M. Do changes in effort-reward imbalance at work contribute to an explanation of the social gradient in angina? Occupational and Environmental Medicine 2005; 62(4): 223-230.

34) Sakata Y, Wada K, Tsutsumi A. Effort-reward imbalance and depression in Japanese medical residents. Journal of Occupational Health 2008; 50(6): 498-504.

35) Conway PM, Campanini P, Sartori S, et al. Main and interactive effects of shift work, age and work stress on health in an Italian sample of healthcare workers. Applied Ergonomics 2008; 39(5): 630-639.

36) Herin F, Paris C, Levant A, et al. Links between nurses' organisational work environment and upper limb musculoskeletal symptoms: independently of effort-reward imbalance! The ORSOSA study. Pain 2006; 152(9): 2006-2015.

37) Markwell AL, Wainer Z. The health and wellbeing of junior doctors: insights from a national survey. Medical Journal of Australia 2009; 191(8): 441-444.

38) Arafa M, Abou Nazel M, Ibrahim N, et al. Predictors of psychological well-being of nurses in Alexandria, Egypt. International Journal of Nursing Practice 2003; 9(5): 313-320.

39) Wisetborisut A, Angkurawaranon C, Jiraporncharoen W, et al. Shift work and burnout among health care workers. Occupational Medicine 2014; 64(4): 279-286.

40) Lee I, Hsiu-Hung W. Perceived occupational stress and related factors in public health nurses. Journal of Nursing Research 2002; 10(4): 253-260.

41) Dagget T, Molla A, Belachew T. Job related stress among nurses working in Jimma Zone public hospitals, South West Ethiopia: a cross sectional study. BMC Nursing 2016; 15: 39.

42) Arora S, Sevdalis N, Nestel D, et al. Managing intraoperative stress: what do surgeons want from a crisis training program? The American Journal of Surgery 2009; 197(4): 537-543.

43) Kawano Y. Association of job-related stress factors with psychological and somatic symptoms among Japanese hospital nurses: effect of departmental environment in acute care hospitals. Journal of Occupational Health 2008; 50(1): 79-85.

44) Casado A, Castellanos A, López-Fernández M, et al. Relationship between oxidative and occupational stress and aging in nurses of an intensive care unit. Age 2008; 30(4): 229-236.

45) Block G, Dietrich M, Norkus E, et al. Factors Associated with Oxidative Stress in Human Populations. American Journal of Epidemiology 2002; 156(3): 274-285.

46) Ayaori M, Hisada T, Suzukawa M, et al. Plasma levels and redox status of ascorbic acid and levels of lipid peroxidation products in active and passive smokers. Environmental Health Perspectives 2000; 108(2): 105-108.

47) Shadab M, Islam N, Khan Z, et al. Oxidative Stress in Sports Persons after a bout of Intense Exercise: A Cross Sectional Study. Biomedical Research 2014; 25(3): 387-390.

48) Pal D, Nimse S. Screening of the antioxidant activity of Hydrilla verticillata plant. Asian Journal of Chemistry 2006; 18 (4): 3004-3008.

49) Dove R, Pheneatia Leong-Smith P, Ester Roos-Engstrand E, et al. Cigarette smoke-induced induction of antioxidant enzyme activities in airway leukocytes is absent in active smokers with COPD. European Clinical Respiratory Journal 2015; 2(1): 27837.

50) Kamal AA, Khafif ME, Koraah S, et al. Blood superoxide dismutase and plasma malondialdehyde among workers exposed to asbestos. American Journal of Industrial Medicine 1992; 21 (3): 353-361.

51) Ahmad I, Temme J, Abdalla M, et al. Redox status in workers occupationally exposed to long-term low levels of ionizing radiation: A pilot study. Redox Report 2016; 21(3): 139-145.

52) Rousseau A, Hininger I, Palazzetti S, et al. Antioxidant vitamin status in high exposure to oxidative stress in competitive athletes. British Journal of Nutrition 2004; 92(3): 461-468.