Research Square

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An investigation of the effect of job stress on oxidative stress in nurses

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Abstract

Background

Nursing is one of the most stressful professions in which nurses are exposed to many physical and psychological stressors due to the need for high level of skill, high concentration, 24-hour care and teamwork. Job stress leads to excessive formation of free radicals, reactive oxygen species, and when the balance between free radical production and antioxidants is disturbed, oxidative stress occurs. The present study aims to determine the effect of job stress on oxidative stress and job performance in nurses in a hospital in western Iran.

Methods

This is a descriptive-analytical cross-sectional study. The study population consisted of 363 employees of a hospital in western Iran (300 nurses and 63 administrative staff). The study sample consisted of 46 nurses and 46 administrative staff who were randomly selected. Data were collected using the Osipow Job Stress Questionnaire and Superoxide dismutase (SOD) Activity Assay Kit, Malondialdehyde (MDA) Assay Kit and Catalase (CAT) Activity Assay Kit. Data were analyzed using descriptive statistics including frequency tables and central and dispersionindexes, and analytical statistics including t-test, analysis of variance, analysis of covariance, Kruskal-Wallis test and correlation coefficients by SPSS 25 software.

Results

The results of the present study indicated that there was a significant difference between the level of job stress in nurses group and administrative staff group ($p < 0.05$). A survey on oxidative stress parameters showed that comparing the mean activity of superoxide dismutaseenzyme (SOD) ($P = 0.083$), malondialdehyde (MDA) ($P = 0.578$) and catalase enzyme (CAT) ($P = 0,592$) did not show a meaningful difference between the two groups, respectively, and stress had no effect on the level of MDA ($P = 0.895$), the level of CAT enzyme ($P = 0.840$) and the level of the SOD enzyme ($P = 0.165$) by modulating the group variables, respectively.

Conclusions

According to the findings of this study, job stress had no effect on oxidative stress measurement parameters. These results may be due to the compatibility of people with stress and the same level of stress. In future work, it is necessary to examine the factors of organizational commitment, spirituality, public health, social support and burnout.

1. Introduction

Stress is a nonspecific reaction caused by stressful factors and conditions in an individual and endangers one's physical and mental health(1).Although there are many different definitions of stress, the scientific definition of stress from the perspective of the proposed model of Richard Lazarus can be expressed as follows: Stress is a condition or feeling in which one perceives that the sum of his desires and expectations are beyond his resources, capabilities and abilities. Also, Lazarus and Folkman (1984) defined stress as a specific relationship between a person and his environment. In fact, it is a stressful relationship between the person and his environment that he suffers from mental and physical problems due to inability to cope with this situation(2). Job stress in the nursing profession increases absenteeism, decreases performance and increases early resignation from work (3). On the other hand, when the balance between free radical production and antioxidants is disturbed, oxidative stress occurs, which leads to cell damage or death, subsequent damage and eventually chronic disease(4).

Hospitals and health centers are like an industrial unit consisting of capital, manpower, technology and management that nurses are among the manpower of these centers and do 80% of the work of medical centers and hospitals (5). Despite the large number of hospitals and various specialties in the medical staff, nurses are at the forefront of providing healthcare services, which in turn complicates and expands their tasks (6). Stress is a word derived from the Latin ‘stringere’, which in the 17th century was used to mean pain and suffering, and the word means pressure – strain or force (7). Stress is an unavoidable part of human life, and today, it includes external stimuli and an individual's response to it and affects all people. Although sometimes it is natural and necessary, if stress is persistent, repetitive and severe, or the person is not able to cope with it or has few sources of support, it becomes a negative phenomenon that causes physical and mental illnesses (7, 8). Job stress can be defined as the interaction between a person’s characteristics and his job in such a way that the job pressure is more than the ability of the person to cope with the job (5).

A nurse can be defined as a person who controls and monitors patients all the working hours and is exposed to the stress of performing these tasks (9, 10). Studies have shown that nurses are considered the largest human resource and medical staff (11). The National Institute of Safety and Health (NIOSH) ranked nursing among the top 40 professions with high stress and stress-related disorders among staff. It is believed that in the case of job stress, nursing may be included in the list of health care (5). After mining, nursing is known as the hardest job in the world and the nursing profession is defined as a job with high stress (12–15).

Several studies address various aspects of the stress that an individual faces in his life, including the following: 1) Stress related to living environment (home), 2) Stress in personal life, and 3) Stress related to workplace (16, 17). One of the most important sources of stress is a person’s job characteristics and job stress has become a common and costly issue in the workplace [18]. Studies have identified job stress as a 20th-century disease and a pervasive issue [19]. Edward and Bernard (2003) have introduced workplace stress as the same as job stress [20]. After disorders, job stress is the second most common work-related problem and absenteeism due to stress costs billions of pounds a year [21].

Many studies have examined the stressors in nurses. In a study by Tyson and his colleagues (2004), workload, dealing with life and death situations and performing tasks beyond capacity and ability [22], and in a study by Ramel and colleagues (2006), high workload, inadequate counseling and communication, inadequate performance feedback, inadequate resources for coping with stress and work-family conflict, were mentioned as major sources of nurses' stress [23].

Job stress leads to excessive formation of free radicals, reactive oxygen species [24]. Reactive Oxygen Species (ROS) can cause diseases such as diabetes, atherosclerosis, cancer and Parkinson's disease [25]. Free radicals in the human body are formed in the cytosol, mitochondria, lysosomes, proxysomes and plasma membranes under both physiological and pathological conditions. They begin as a cascade and cause peroxidation of fat cells that directly damage the biological membrane, producing a number of by-products such as aldehydes and malondialdehyde (MDA), of which aldehydes are the most abundant due to the fat oxidation [26]. The human body has an integrated antioxidant system which includes enzymatic and non-enzymatic antioxidants that are usually effective in preventing the harmful effects of free radicals. Normally, antioxidants convert ROS to H_2O, which prevents the increase of reactive oxygen species. Enzymatic antioxidants, including superoxide dismutase (SOD), glutathione peroxide (GPX), and catalase (CAT), are responsible for intracellular protection [27]. Tsuboi and his colleagues (2006) indicated that the association between high levels of MDA and burnout symptoms in participants was low and there was a significant positive difference between the levels of MDA/TC ratio in low stress [28].

Salem and her colleagues conducted a study entitled "Psychosocial Work Environment and oxidative stress among Nurses" in 2016. The results of his study showed that MDA was significantly positively correlated with E/R and work stress, which was common among nurses, showed a high correlation between ERI and MDA levels and the highest stress was reported in hospital wards, ICUs, and operating rooms [29].

Adriano Silva Silveira and his colleagues conducted a study entitled "Oxidative stress effects in the uterus, placenta and fetus of pregnant rats submitted to acute and chronic stress" in 2018.The results suggested that there was no meaningful difference in MDA levels, but there was a correlation between infant size, placental weight and MDA levels. In this study, stress had negative effects on the group exposed to chronic stress compared to the control group, the rats exposed to chronic stress had fewer placentas, embryos and infants compared to the other groups and abortion rates were also higher in this group [30].

A cross-sectional study entitled "Relation between Job stress and Oxidative stress Biomarkers among Nurses in Zagazig University Hospitals" was conducted by Amira Shawally Mohamed and her colleagues in 2019. The results showed that the rate of severe stress in nurses was 65% and in administrative staff was 7.5% and the levels of MDA and SOD in nurses were significantly higher than the administrative or control group [31].

Based on what mentioned above, the present study aims to determine the effect of job stress on oxidative stress in nurses of a hospital in western Iran.

2. Method

2.1. Research design, sampling and data gathering

This research is a descriptive-analytical study that was conducted cross-sectionally in 2019 between two groups of nurses and administrative staff. All nurses and administrative staff of Kosar Hospital in Sanandaj City were included in this study in the first stage. In the second stage, by random sampling and observing the inclusion criteria and also examining the homogeneity of demographic samples, a total of 92 nurses and administrative staff were included in the study to compare stress and job performance and measure oxidative stress parameters.

In the present study, the level of job stress of all administrative staff and nurses was measured using the Osipow job stress questionnaires. Then, by random sampling and examining the homogeneity of demographic characteristics, the necessary samples were selected to measure the oxidative stress parameters.

The data required for this research were collected by the following tools:

1. The revised Osipow Job Stress Questionnaire,
2. Demographic questionnaire, and
3. Superoxide dismutase (SOD) Activity Assay Kit, Malondialdehyde (MDA) Assay Kit, and Catalase (CAT) Activity Assay Kit.

2.2. The Osipow Job Stress Questionnaire:

It was developed in 1987 by Osipow and Spokan to assess a person's stress in his workplace. The Osipow Job Stress Questionnaire is used to examine and measure job stresses caused by job roles. The purpose of the Osipow Job Stress Questionnaire is to determine the severity and difference in severity of job role-induced stresses in different organizational employees [32].

Dimensions and components of the Osipow Job Stress Questionnaire include the following six dimensions:

Role workload, Incompetency of role, Role ambiguity, Role boundary, Responsibility, and Physical environment.

Scoring and interpretation method: The scoring of the Osipow Job Stress Questionnaire based on the 5-point Likert scale is as follows. The range of scores of this questionnaire varies between 60 and 300. The

higher the subjects' scores in this questionnaire, the higher their stress level. Also, the overall stress level in the four categories is as follows:

1. A score of 50–99 from the questionnaire means low stress.
2. A score of 100–149 from the questionnaire means low to moderate stress.
3. A score of 150–199 from the questionnaire means moderate to severe stress.
4. A score of 200–250 from the questionnaire means severe stress.

Reliability and validity of the questionnaire: The reliability of this questionnaire was calculated at a satisfactory level by re-testing in an article entitled "Clinical competence and job stress of nurses in hospitals affiliated to Ahvaz Jundishapur University of Medical Sciences" conducted by Komeili Sani and his colleagues in 2013 and Cronbach's alpha was 0.89 [33].

2.3. Demographic questionnaire:

It is a questionnaire to collect data on demographic factors (including age, gender, work experience or service history, education, marital status, work system, smoking, number of daily cigarette, physical activity status, amount of consumption of fruits and vegetables, etc.).

2.4. Superoxide dismutase (SOD) Activity Assay Kit, Malondialdehyde (MDA) Assay Kit and Catalase (CAT) Activity Assay Kit:

Malondialdehyde (MDA) Assay Kit: Having 92 tests, this kit was used to measure malondialdehyde levels in biological samples such as serum, plasma, urine, homogeneous tissue, and cell lysate, and direct damage of oxidants was measured in the serum by this kit in this study.

Superoxide dismutase (SOD) Activity Assay Kit: Having 92 tests, this kit was used to measure the superoxidase dismutase enzyme activity in biological samples such as serum, plasma, urine, homogeneous tissue, cell lysate and the activity of this enzyme as an antioxidant was measured in the serum in this study.

Catalase (CAT) Activity Assay Kit: Having 92 tests, this kit was used to measure catalase activity in biological samples such as serum, plasma, urine, homogeneous tissue and cell lysate, and the activity of this enzyme as an antioxidant was measured in serum in this study. Malondialdehyde (MDA) Assay Kit and Superoxide dismutase (SOD) Activity Assay Kit were purchased from Teb Pazhouhan Razi (TPR) Co. located in the Research Center of Iran University of Medical Sciences, and Catalase (CAT) Activity Assay Kitwas purchased from Kia Zist Co. In this study, individuals with inclusion criteria, including having at least one year of work experience, having conscious consent to participate in the study, not being pregnant, not having chronic disease (kidney, liver, diabetes), not having acute infectious disease,

malignant disease and mental disorders, and not consuming antioxidant pills (vitamins E and A, and minerals), were included in the study.

2.5. Data analysis

Data were analyzed using descriptive statistics including frequency tables and central and dispersion indexes, and analytical statistics including t-test, analysis of variance, analysis of covariance, Kruskal-Wallis test and correlation coefficients by SPSS 25 software.

3. Results

The main variables of this study include the job stress level, the level of oxidative stress parameters of superoxide dismutase (SOD) enzyme, malondialdehyde (MDA) and catalase (CAT) in the nurses group and the administrative staff group; Also, investigation of the effect of job stress on oxidative stress in the two groups and comparison of the level of oxidative stress parameters of superoxide dismutase (SOD) in the study groups are considered.

Descriptive Statistics Section: In this section, the findings of descriptive statistics of the measured variables related to 46 nurses and 46 administrative staff of the studied hospital are presented. Also, comparisons have been made to investigate the homogeneity of the two groups in terms of confounding variables. The results of this study indicate that work system as regular and shift work is different in the nurses group and the administrative staff group. In the nurses group, the work system is mostly shift work, while in the administrative staff group, it is mainly regular.

The results of frequency distribution and percentage of qualitative variables of the study in the nurses group and the administrative staff group are shown separately in Table 1.

Also, the results showed that the there was no significant difference between the average work experience and the amount of fruit and vegetable consumption in the two groups of nurses and administrative staff, but in terms of age the two groups were significantly different at 5%. These results are shown in Table 2. According to this table, it can be said that the nurses group was generally younger than the administrative staff group and more than 50% of the staff in both groups had less than 5 years of work experience. Also, the amount of consumption of vegetables and fruits above 300 grams per day is relatively high in both groups.

Analytical statistics section: Comparison of job stress and analysis of oxidative stress parameters in the two groups according to Table 3 shows that the mean and standard deviation of stress level in the nurses group were 186.34 and 24.26 years, respectively, and in the administrative staff group, 176.32 and 22.03, respectively; statistically, it shows a meaningful difference at the level of 5%. In other words, the average job stress in nurses is higher than administrative staff ($P < 0.05$). Also, based on the Osipow Job Stress Questionnaire leveling, both groups of nurses and administrative staff were mostly in moderate to severe stress level. The mean and standard deviation of CAT enzyme level in the nurses group were 3.94 and 1.59 mU/mL, respectively, and in the administrative staff group, were 3.75 and 1.79 mU/mL, respectively,

which was not statistically significant; that is, there was no significant difference between the level of CAT enzyme activity in the nurses group and the administrative staff group (P = 0.592). The mean and standard deviation of SOD enzyme level in the nurses group were 358.77 and 34 units per ml, respectively, and in of administrative staff group, were 369.28 and 22.16 units per ml, respectively, which was not statistically significant; that is, there was no meaningful difference between the level of SOD enzyme activity in the nurses group and the administrative staff group (P = 0.083).And the mean and standard deviation of MDA enzyme level in the nurses group were 12.24 and 4.27 µmol, respectively, and in the administrative staff group, were 11.75 and 4.14µmol, respectively, which was not statistically significant; that is, there was no meaningful difference between the level of MDA in the nurses group and the administrative staff group (P = 0.578).

Investigation of the effect of job stress on oxidative stress parameters: To investigate the effect of job stress on oxidative stress parameters in the nurses group and the administrative staff group, analysis of covariance (ANCOVA) was used. Since, at the design stage, homogenization of the two groups in terms of age and work system variables was no achieved, so at first it seemed that these two variables had the role of confounding variables in the mentioned investigation, but in this study, according to Table 4 and Table 5, age and work system variables did not show a significant effect on job performance; therefore, these two variables were not included in the analysis of variance. To investigate the effect of job stress on MDA, SOD and CAT based on the study groups, the results are presented in Table 6, after reviewing and confirming the assumptions of analysis of covariance. The results showed that there was no effect of job stress on MDA, SOD and CAT parameters. Also, by modulating the effect of stress, the amount of MDA, SOD and CAT are the same in both study groups (nurses and administrative staff).

4. Discussion And Conclusion

The results of the present study showed that job stress in the nurses with a score between 150–199 was at the level of moderate to severe stress, and job stress in the administrative staff was also at the level of moderate to severe stress with a score between 150–199, but statistically there was a significant relationship between the average job stress in the two groups ($p < 0.05$).

A study was conducted in China in 2012 by Yau and colleagues to determine the level of job stress and stressors in Zhuhai Hospital in China, which was consistent with our study in terms of stress levels in nurses [34].

Also, a study was conducted in England in 1992 by David Rees and Cary L Cooper to determine stress levels in 1176 health care workers compared with the normal group including the employees who are not health care workers. Its results were consistent with the results of our study [35].

Our results also are consistent with the results of a study conducted by Rees and his colleagues (1995) who aimed to determine stress management in six occupational groups (nurses and ward nurses, administrative staff, physicians, on-call employees and specialist physicians). The findings suggested

that the administrative staff group scored lower in terms of job stress than other groups, and this showed a statistically significant difference [36].

In this regard, another study was conducted by Parastoo Golshiri and her colleagues In Iran in 2012 to evaluate and compare job stress in female nurses in the emergency department and female secretaries (female administrative staff) at Al-Zahra Hospital. Their results were consistent with our results. Also, the results of our study were consistent with the results of the study conducted by Yang and his colleagues (2001) [37, 38].

However, the findings of our research contradict the results of a study conducted by Callaghan and his colleagues (2000).Their results indicated that job stress in nurses is less than in other groups. One of the reasons for the dissimilarity of the results of their study with the present study is the difference in the population of this study and the adaptation of nurses with severe and chronic exposure conditions to stressful working conditions [39].

Comparison of oxidative stress parameters of MDA, SOD and CAT in two groups

The results of the present study indicate that there was no statistically significant difference in the levels of oxidative stress parameters of malondialdehyde (MDA), catalase (CAT) enzyme and superoxide dismutase (SOD) enzyme in the nurses and the administrative staff group. The results of the present study were consistent with Casado's study in 2008 regarding comparing CAT in two groups (intensive care unit nurses and control group). In Casado (2008), no comparisons were made between MDA level and SOD activity in the two groups. The results of our study were inconsistent with the study of Morgan Casado and colleagues (2005) in a meaningful difference in the amount of SOD in the two groups. And also it was inconsistent with the study of Amira Shawally and her colleagues (2019). The dissimilarity of these studies with the present study may be due to the fact that in the present study inclusion criteria such as not consuming vitamins E and A and minerals, not having mental disorders, acute and malignant infectious diseases, liver diseases, kidney diseases and diabetes, not being pregnant and not smoking, were considered, and this caused no meaningful difference in the level of oxidative parameters between the two groups. Also, the reason for the dissimilarity of the results of our study with the study of Morgan Casado (2005) may be due to difference in the tools used to measure job stress, climatic differences, differences in lifestyle, working and environmental conditions and the difference in stress levels between the two groups [31, 40–41].

Comparison of the effect of job stress on the level of oxidative stress parameters of MDA, SOD, and CAT

The results of the present study showed that job stress had no effect on the level of stress oxidative parameters of catalase (CAT), malondialdehyde (MDA) and superoxide dismutase (SOD) by modulating the group, which was inconsistent with the studies of Morgan Casado (2005) and Casado (2011), but was consistent with the studies of Adriano Silva Silveira and colleagues (2018), and Bardhan and her colleagues (2019). According to the research findings, job stress had no effect on the parameters of oxidative stress [30, 41–43].

Also, the parameters of oxidative stress did not show a significant difference between the two groups by modulating the stress variable. These results may be due to the adaptation of people to stress and the same level of stress in the two groups. It is necessary to investigate organizational commitment, spirituality, general health, social support, burnout, climate difference and people with severe stress levels in the future work.

5. Abbreviations

SOD
Superoxide dismutase
MDA
Malondialdehyde
CAT
Assay Kit and Catalase
SPSS
Statistical Package for the Social Sciences
NIOSH
National Institute of Safety and Health
ROS
Reactive Oxygen Species
ICU
Intensive Care Unit

6. Declarations

Ethics approval and consent to participate: Ethics of this study was approved by Shahid Beheshti University of Medical Sciences (ethic No. IR.SBMU.PHNS.REC.1397.102).

Consent for publication: All authors have consent for publication.

Availability of data and materials: Not applicable

Competing interests: Authors declare that there is no competing of interests.

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Authors' contributions: A.S.S was the leader of study and edited the final manuscript. B.M gathered data for study and gathered the questionnaire and was a major contributor in writing the manuscript. D.P gathered data for oxydativestress and was a major contributor in writing the manuscript. A.K analyzed data and was a major contributor in writing the manuscript. All authors read and approved the final manuscript."

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8. Tables

Table 1. Frequency distribution and percentage of qualitative variables of the study in two groups of nurses and administrative staff

Variable		Nurses Group		Administrative Staff Group		p-value
		number	percent	number	percent	
Gender	Male	27	58.7	24	52.2	
	Female	19	41.3	22	47.8	0.529
	Total	46	100	46	100	
Work System	Regular	13	28.3	41	89.1	0.000
	Shift	33	71.7	5	10.9	
Marital Status	Single	23	50	13	28.2	0.072
	Married	23	50	32	69.6	
	Divorced	46	100	1	2.2	
Level of Education	Associate's Degree	2	4.35	6	13.1	0.578
	Bachelor's Degree	41	89.13	25	54.3	
	Master's Degree	3	6.52	15	32.6	
Activity Level	Always	12	26.1	8	17.4	0.598
	Sometimes	28	60.9	31	67.4	
	Never	6	13.0	7	15.2	

Table 2. Descriptive findings of variables of age, work experience, and fruits and vegetables consumption in two studied groups

Variables	Nurses Group		Administrative Staff Group		p-value
	M	SD	M	SD	
Age (year)	29.87	4.529	33.65	5.967	0.001
Work Experience (year)	5.543	3.538	7.674	7.27	0.079
Consumption of Fruits and Vegetables	331.96	249.17	431.52	309.36	0.093

Table 3. Comparison of job stress, CAT and SOD enzymes, and MDA level in the two studied groups

Variables	Group	Mean	SD	P-value
Job Stress	Nurses	186.34	26.26	0.041*
	Administrative Staff	176.32	22.03	
SOD (U/ml)	Nurses	358.77	34	0.083
	Administrative Staff	369.28	22.16	
MDA (Mm)	Nurses	12.24	4.27	0.578
	Administrative Staff	11.75	4.14	
CAT (nmol/ml)	Nurses	3.94	1.59	0.592
	Administrative Staff	3.75	1.79	

Statistically significant values are shown, *$p < 0.05$

Table 4. Effect of work system on MDA level and CAT and SOD enzymes activity levels

	Work System	Mean	SD	Type of Test	p-value
MDA (Mm)	Regular	11.96	4.79	T-test	0.931
	Shift	12.03	3.20		
SOD (U/ml)	Regular	362.19	362.19	T-test	0.449
	Shift	366.63	366.63		
CAT (nmol/ml)	Regular	3.79	3.79	T-test	0.705
	Shift	3.93	3.93		

Table 5. Effect of age on MDA level and SOD and CAR enzymes activity levels

. Predictors Variables	. Predictors Variables	B	SE	Beta	T	p-value
MDA (Mm)	Constant	11.046	2.541	0	4.347	0.000
	Age	0.030	0.079	0.040	0.379	0.705
SOD (U/ml)	Constant	351.931	17.569	0	20.031	0.000
	Age	0.381	0.545	0.073	0.699	0.486
CAT(nmol/ml)	Constant	3.653	1.025	0	3.563	0.001
	Age	0.006	0.032	0.021	0.199	0.843

Table 6. Effect of job stress on MDA, SOD and CAT based on the groups studied

Oxidative Stress Parameter	Variables	F	Sig	Type of Test
MDA (Mm)	Intercept	12.558	0.001	ANCOVA
	Stress	0.018	0.895	
	Group	0.326	0.569	
SOD (U/ml)	Intercept	279.805	0.000	ANCOVA
	Stress	1.961	0.165	
	Group	2.035	0.157	
CAT (nmol/ml)	Intercept	8.515	0.004	ANCOVA
	Stress	0.041	0.840	
	Group	0.320	0.573	

Statistically significant values are shown, *p < 0.05