

## OCCUPATIONAL HAZARDS RISK ASSESSMENT OF NURSES WORKING IN OPERATING ROOMS

By

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### Abstract

**Introduction:** Operating room nurses ( ORN) are exposed to various hazards in operating rooms (ORs) which can affect their health. **Aim of work:** To identify potential occupational hazards in the OR , to assess the risk of adverse health effects among (ORN) related to these hazards and to recommend prevention and control measures to protect them .**Materials and methods:** This cross-sectional study targeted all nurses staff working in ORs in Benha University Hospitals, Qualubeyia Governorate, Egypt. Data were collected using an interview questionnaire included demographic data and occupational history with special emphasis on occupational hazards in ORs based on the International Hazard Datasheet on Operating room nurse. Data on attitude towards OR hazards and their impacts on ORN were also obtained Their mean age was . **Results:** The study recruited 167 female nurses.  $32.77\pm8.42$  years old. More than 90% were acquainted with the concept of OR occupational hazards. Eighty four percent of the studied nurses reported that they were adversely affected by OR occupational hazards. The risk of exposure was high for radiation, blood borne diseases and contracting nosocomial diseases. The risk was significant for exposure to anesthetic drugs and gases, latex allergy and muscle pain due to awkward body positions.**Conclusion:** The complex structure of operating rooms lead to increased occupational hazards which affect operating room nurses' health.

**Keywords:** Operating room nurses ( ORN) ,Operating room(OR), International Hazard Datasheet , Blood borne diseases and Anesthetic gases .

## Introduction

Operating rooms (ORs) are unique from other work environments with respect to their construction and working conditions. The systems, long work hours, and stressful environment can negatively affect the health of operating room nurses (ORNs) (Aljeesh and Al Nawajha,2011). OR environment is of great importance in the hospital among other healthcare settings. The nature of surgeries makes characters of nurse's work in the OR to be fast-paced, highly-loaded, and changeful. With the rapid development of medical science; ORN job content becomes highly extensive (Danjuma et al.,2016).The International Labor Organization (ILO) has classified the conditions that create health risks for nurses who are working in OR as biological, chemical , physical and psychosocial hazards, ergonomic, and organizational factors. Nurses who are working in OR are exposed to health risks such as injuries caused by sharp objects used during surgery, exposure to anesthetic gases, medications, and radiation, the effects of disinfectants, sterilizing gas, and other cleaning agents on the skin, mucosa, respiratory system and burns from contact with hot surfaces, electricity, or fires.

Musculoskeletal problems among ORNs are commonly lumbar pain from lifting heavy patients and fatigue and lower extremity problems from standing for long periods. ORNs suffer stress and exhaustion from working shifts (Ugurlu et al.,2015and ILO,2000).

Risk is the likelihood, or possibility, that harm (injury, illness, death, damage etc.) may occur from exposure to a hazard. Risk analysis is a combination of the likelihood of the occurrence of a hazardous event with specified period or in specified circumstances and the severity of injury or damage to the health of people (OSHA,2014). The purpose of a risk analysis is to determine whether there is any likelihood of a potentially hazardous situation causing death, injury or illness to people in the workplace, how severe that risk is and whether the risk needs to be controlled and how urgently (Berg, 2010). The Proportional Risk Assessment Technique (PRAT) was developed by Kinney and Wiruth in 1976 and used a proportional formula for calculating the quantified risk due to hazard. The risk is calculated considering the potential consequences of an accident, the exposure factor and the probability factor (Marhavilas et

al., 2011). Occupational hazards in OR affect nurses' health and can lead to death. Also lack of nurses' knowledge and improper performance towards how to protect themselves increase the effect of work-related hazards (Xueqin et al, 2015). Nonetheless, there are lacking in studies which focus on OR health hazards among nurses. This study was conducted to assess these hazards and develop recommendations to minimize operative room hazards and control related adverse effects among ORNs working in Benha University Hospitals, Egypt.

### Aim of work

To identify potential occupational hazards in the OR , to assess the risk of adverse health effects among (ORN) related to these hazards and to recommend prevention and control measures to protect nurses in Benha University Hospitals.

### Materials and methods

**Study design:** It was a cross-sectional study.

**Place and duration of study:** The study was conducted in Benha University Hospitals, Qualubeyia Governorate, Egypt; during the period from the beginning of March to the end of August 2016.

**Study sample:** The study involved all nurses who are working in OR in Benha University Hospitals' different surgical departments who accepted to participate in the study. Out of 171;167 nurses accepted to participate with a response rate 97.6 %.

**Study methods:** An english questionnaire was used. A pilot study was undertaken on 15 nurses at the department of General Surgery and it was not included in the study.-

Data were collected using an interview questionnaire based on the International Hazard Datasheet on ORN, which was developed by the International Labor Organization (Fine,1971) .

**Risk assessment:** A standardized risk assessment matrix was used to calculate risk score, prioritize intraoperative high risk areas for future health and safety interventions. The risk score was calculated as follows:

Total rik score=frequency×severity×likelihood

Nurses were asked about 21 occupational hazards. Responses to questions on frequency of exposure were coded as 0.5, 1, 2, 3, 6 and 10 corresponding to the occurrence of

hazards *very rare, rare, infrequent, occasional, frequent or continuous*. Responses to questions on severity of hazards consequences were coded as 100, 50, 25, 15, 5 and 1 corresponding to the possible consequences of event may be *catastrophic, very serious, serious, major, moderate or insignificant*. Responses to questions on the likelihood of hazards were coded as 10, 6, 3, 1, 0.5 and 0.1 corresponding to that the probability may be *almost certain, likely, possible, remotely possible, very unlikely or impossible*. Then the risk was categorized according to the required action for control as *very low risk (<20), possible risk (20-70), significant risk (70-200), high risk (200-400) and catastrophic risk (>400)* (Foxall et al., 1990).

## Consent

An informed consent was obtained from all participants. It included all details about the study (title, objectives, methods, expected benefits and risks and confidentiality of data).

## Ethical approval

An approval from the Research Ethics Committee at Benha Faculty of Medicine was obtained to conduct this work.

## Data management

The statistical analysis was conducted using STATA/SE version 11.2 for Windows (STATA Corporation, College Station, Texas). Statistical significance was accepted at p value <0.05.

## Results

The study population comprised of 167 female nurses who were at the work force during the period of the study. The age of nurses ranged between 20 and 57 years with a mean  $32.77 \pm 8.42$  years and 57.49 % of them were from urban areas. The mean working duration of the studied nurses was  $15.81 \pm 7.04$  years and ranged between 3 and 36 years. More than 89 % of the studied nurses' occupational health became worse after working in OR. The proportion of the studied nurses who reported that work-related health problems affect work efficiency often was 23.95%, sometimes was 32.93% and occasional was 25.75%. The most frequent response to OR related health hazards was worry and didn't know what to do (55.09%). Forty four percent of studied nurses thought that working in OR is stressful and exhausting and 32.34 % thought that it's challenging and difficult ( Results are not tabulated).

**Table (1): Operating rooms hazards risk categories according to the fine risk score.**

Risk score	Physical hazards	Chemical hazards	Biological hazards	Ergonomic, psychosocial & organizational factors
Very low risk (<20)	<ul style="list-style-type: none"> <li>• Sharp objects</li> <li>• Burns and scalds from hot sterilizing equipment.</li> <li>• Electrical shock</li> </ul>	<ul style="list-style-type: none"> <li>• Chronic poisoning due to long-term anesthetic gases and sterilizing fluids.</li> </ul>	<ul style="list-style-type: none"> <li>• Possibility of contracting palm and finger herpes.</li> </ul>	<ul style="list-style-type: none"> <li>• Problems of interpersonal relations with surgeons.</li> <li>• Exposure to severely traumatized patients.</li> </ul>
Possible risk (20-70)	<ul style="list-style-type: none"> <li>• Falling objects, e.g., medical instruments.</li> <li>• Slips, trips, and falls on wet floors</li> </ul>	<ul style="list-style-type: none"> <li>• Skin problems due to frequent use of disinfectants.</li> <li>• Irritation of the eyes, nose, and throat due to airborne aerosols of cleaning liquids.</li> </ul>	<ul style="list-style-type: none"> <li>• Increased hazard of spontaneous miscarriages.</li> </ul>	<ul style="list-style-type: none"> <li>• Stress caused by feeling of heavy responsibility towards patients.</li> <li>• Strained family relations, and burnout due to shift work and overtime work</li> </ul>
Significant risk (70-200)		<ul style="list-style-type: none"> <li>• Anesthetic drugs and gases.</li> <li>• Latex allergy.</li> </ul>		<ul style="list-style-type: none"> <li>• Chronic muscular skeletal pain due to handling patients</li> <li>• Acute muscle pain due to awkward body position .</li> </ul>
High risk (200-400)	<ul style="list-style-type: none"> <li>• Exposure to radiation from x-ray</li> </ul>		<ul style="list-style-type: none"> <li>• Exposure to blood, body fluids or tissue specimens.</li> <li>• Risk of nosocomial disease as a result of a prick from a needle.</li> </ul>	

Total No of nurses=167

Table (1) showed ORs hazards risk categories according to the Fine risk score. As regard physical hazards, the risk of exposure was high (mean  $\pm$  SD:  $245.8 \pm 470.5$ ) for radiation. As regard chemical hazards, the risk of exposure to anesthetic drugs and gases ( $89 \pm 138.9$ ) and latex allergy ( $87.2 \pm 108.9$ ) was significant. As regard biological hazards, the risk of exposure to blood ( $339.2 \pm 383.8$ ) and contracting nosocomial diseases ( $350.8 \pm 332.4$ ) was high. As regard ergonomic, psychosocial and organizational hazards, the risk of acute muscle pain due to awkward body position or overexertion ( $158 \pm 170.1$ ) and chronic pain due to handling patients and prolonged standing ( $165.5 \pm 223.3$ ) was significant.

**Table (2): Differences in operating rooms physical hazards risk scores by demographic characteristics and work situations of the studied nurses.**

Physical Hazards risk scores Variables	Falling objects (Mean $\pm$ SD)	Slips, trips, and falls (Mean $\pm$ SD)	Sharp objects (Mean $\pm$ SD)	Burns and scalds (Mean $\pm$ SD)	Radiation (Mean $\pm$ SD)
<b>Age (years)</b>	m	m	m	m	m
<32	52.08 $\pm$ 144.62	27.77 $\pm$ 69.16	9.22 $\pm$ 15.74	13.79 $\pm$ 19.23	291.04 $\pm$ 535.35
$\geq$ 32	30.74 $\pm$ 64.05	21.47 $\pm$ 40.46	13.94 $\pm$ 26.30	10.46 $\pm$ 16.66	202.23 $\pm$ 396.62
<b>Residence</b>	m	m	m	m	m
Rural	34.39 $\pm$ 67.13	26.56 $\pm$ 67.85	11.29 $\pm$ 17.63	11.90 $\pm$ 17.62	251.56 $\pm$ 515.32
Urban	50.45 $\pm$ 152.08	21.85 $\pm$ 35.53	12.07 $\pm$ 26.60	12.36 $\pm$ 18.60	238.10 $\pm$ 405.72
<b>Work duration</b>	m	*m	m	*m	m
<15	54.87 $\pm$ 148.74	29.52 $\pm$ 71.25	8.77 $\pm$ 16.12	15.12 $\pm$ 21.30	298.25 $\pm$ 553.25
$\geq$ 15	29.54 $\pm$ 62.67	20.32 $\pm$ 39.27	14.05 $\pm$ 25.57	9.50 $\pm$ 14.20	201 $\pm$ 383.70
<b>Shift duration (hours)</b>	m	m	m	*m	m
6	15 $\pm$ 6	5.25 $\pm$ 3.59	1.94 $\pm$ 2.18	1.25 $\pm$ 0.50	0.00 $\pm$ 0.00
8	41.86 $\pm$ 112.62	25.04 $\pm$ 56.93	11.86 $\pm$ 22.04	12.36 $\pm$ 18.13	251.87 $\pm$ 474.73
<b>Number of shift work</b>	***k	*k	k	*k	k
1	13.17 $\pm$ 17.02	6.46 $\pm$ 8.54	3.83 $\pm$ 8.40	10.92 $\pm$ 12.46	125.00 $\pm$ 433.01
2	16.54 $\pm$ 31.37	32.39 $\pm$ 52.80	14.05 $\pm$ 21.81	7.01 $\pm$ 10.49	158.94 $\pm$ 236.63
3	55.07 $\pm$ 135.01	23.17 $\pm$ 60.41	11.43 $\pm$ 22.76	14.43 $\pm$ 20.54	297.08 $\pm$ 540.90
<b>Nature of work</b>	****k	k	k	k	****k
Scrubbing nurse	48.70 $\pm$ 121.57	27.36 $\pm$ 61.44	11.67 $\pm$ 22.21	12.08 $\pm$ 18.43	229.60 $\pm$ 494.94
Circulating nurse	8.50 $\pm$ 9.94	6.69 $\pm$ 10.58	5.47 $\pm$ 10.08	11.50 $\pm$ 12.76	187.50 $\pm$ 530.33
Anesthesia nurse	6.52 $\pm$ 14.39	13.65 $\pm$ 17.10	13.54 $\pm$ 22.76	12.40 $\pm$ 17.44	368.18 $\pm$ 226.81
<b>Department</b>	***k	***k	k	k	***k
Emergency	91.21 $\pm$ 208.38	15.92 $\pm$ 21.16	15.10 $\pm$ 40.88	17.43 $\pm$ 23.82	-
General surgery	26.41 $\pm$ 30.95	6.33 $\pm$ 7.60	6.61 $\pm$ 9.67	14.69 $\pm$ 23.32	-
ENT	25.07 $\pm$ 28.23	16.27 $\pm$ 19.11	15.97 $\pm$ 22.99	11.1 $\pm$ 10.44	-
Obstetrics & gynecology	39.67 $\pm$ 47.57	37.9 $\pm$ 46.54	7.97 $\pm$ 9.14	7.5 $\pm$ 8.03	-
Urology	62.07 $\pm$ 135.15	4.57 $\pm$ 4.39	23.43 $\pm$ 26.37	18.83 $\pm$ 27.01	629 $\pm$ 437.70
Ophthalmology	14.72 $\pm$ 11.73	36.83 $\pm$ 72.19	12.72 $\pm$ 24.41	3.03 $\pm$ 2.67	-
Neurosurgery	10.00 $\pm$ 16.52	24.71 $\pm$ 50.19	6.57 $\pm$ 8.47	8.84 $\pm$ 7.95	-
Cardiothoracic	25.59 $\pm$ 28.28	10.18 $\pm$ 14.10	6.68 $\pm$ 5.58	8 $\pm$ 6.05	-
Orthopedic	90.73 $\pm$ 192.00	63.45 $\pm$ 118.56	6.59 $\pm$ 11.03	16.04 $\pm$ 23.10	1069.09 $\pm$ 655.60
Anesthesia	6.52 $\pm$ 14.39	13.65 $\pm$ 17.10	13.54 $\pm$ 22.76	12.40 $\pm$ 17.44	368.18 $\pm$ 226.81

\*, \*\*, \*\*\*: Statistically significant at  $p<0.05$ ,  $p<0.01$ ,  $p<0.001$

m: Mann-Whitney test;

k: Kruskal Wallis test

- **Scrubbing nurse** : are registered nurses who assist in surgical procedures by setting up the room before the operation, working with the doctor during surgery and preparing the patient for the move to the recovery room(Williams,2018 ).
- **Circulating nurse**: is a registered nurse who works in the operating room environment. The circulating nurse does not scrub in and performs job duties that cannot be done by staff that is scrubbed in and must remain sterile (Whitlock,2019).
- **Anesthesia nurse**: who administers anesthesia for surgery or other medical procedures (MacGill,2017).

Table (2) showed that there was significant differences ( $p<0.001$ ) between radiation risk score by the nature of work and the working unit. The highest score was among anesthesia nurses ( $368.18\pm226.81$ ) and nurses who were working at the Orthopedic department ( $1069.09\pm655.60$ ). There were significant differences ( $p<0.001$ ) between falling objects risk score by the nature of work,number of shifts and the working unit.The highest score was among scrubbing nurses ,nurses who work in Emergency department and who worked 3 shifts per week. There were significant differences ( $p<0.05$ ) between slips and falls risk score by work duration,number of shifts and the working unit. The highest score was among nurses who worked for less than 15 years, who worked 2 shifts per week and Orthopedic department nurses.

**Table (3) : Differences in operating rooms chemical hazards risk scores by demographic characteristics and work situations of the studied nurses.**

Chemical Hazards risk scores Variables	Anesthetic drugs and gases (Mean ±SD)	Skin problems due to frequent use of disinfectants (Mean ±SD)	Latex allergy (Mean ±SD)
<b>Age (years)</b>	m	m	m
<32	72.27±84.09	64.97±112.15	86.29±106.43
≥32	105.21±175.52	67.33±101.10	88.09±111.94
<b>Residence</b>	m	m	m
Rural	95.86±170.61	67.38±102.54	81.34±103.44
Urban	79.8±78.39	64.53±112.02	95.14±116.25
<b>Work duration (years)</b>	m	m	m
<15	76.06±83.28	71.95±116.94	88.27±109.29
≥15	100.13±172.71	61.23±96.77	86.3±109.25
<b>Shift duration (hours)</b>	m	m	m
6	85.5±143.11	63.75±77.82	103.75±56.18
8	89.12±139.32	66.23±107.13	86.8±109.98
<b>Number of shift work</b>	k	k	k
1	202.5±420.7	61.08±64.49	75.33±73.87
2	106±95.01	46.19±94.31	80.11±99.45
3	69.05±76.89	75.43±114.15	91.62±116.37
<b>Nature of work</b>	k	*k	k
Scrubbing nurse	88.03±146.13	75.13±113.62	90.9±113.35
Circulating nurse	54±78.28	40.37±58.77	55.12±64.38
Anesthesia nurse	108.04±107.1	19.77±40.3	75.86±92.76
<b>Department</b>	***k	*k	***k
Emergency	24.16±27.22	37.58±70.34	121.21±107.02
General surgery	65.31±85.51	69±126.0	138±166.85
ENT	175.2±375.65	22.73±31.65	138.47±134.62
Obstetrics & gynecology	87.47±76.43	27.2±45.16	59.53±86.2
Urology	93.27±86.24	93.2±142.59	50.4±75.39
Ophthalmology	108±97.23	111.72±134.78	121.28±111.31
Neurosurgery	45±52.45	89.64±106.43	76.14±131.15
Cardiothoracic	104.64±105.76	116.36±127.12	22.36±16.34
Orthopedic	87.45±77.85	95.68±129.9	52.86±53.18
Anesthesia	108.04±107.1	19.77±40.3	75.86±92.76

\*,\*\*: Statistically significant at  $p<0.05$  and  $p<0.01$

m: Mann-Whitney test; k: Kruskal Wallis test

Table (3) showed that there was a significant difference ( $p<0.01$ ) in anesthetic drugs and gases risk by the working unit with the highest score was among nurses working at the ENT department ( $175.2\pm375.65$ ). The risk of latex allergy was significantly ( $p<0.01$ ) higher among nurse who were working at the ENT department ( $138.47\pm134.62$ ) and General Surgery department (mean  $138\pm166.85$ ). There was a

significant difference ( $p<0.05$ ) in skin problems due to frequent use of disinfectants risk by nature of work and working unit with the highest score was among scrubbing nurses and nurses who were working at the Orthopedic department.

**Table (4): Differences in operating rooms biological hazards risk scores by demographic characteristics and work situations of the studied nurses.**

Biological Hazards risk scores Variables	(Mean $\pm$ SD)			
	Exposure to blood, body fluids	Nosocomial disease	Palm and finger herpes	Spontaneous miscarriages
<b>Age (years)</b>	m	m	m	m
<32	340.1 $\pm$ 335.08	367.19 $\pm$ 363.56	1.76 $\pm$ 1.13	33.28 $\pm$ 90.28
$\geq$ 32	338.34 $\pm$ 427.65	335.09 $\pm$ 300.71	1.61 $\pm$ 0.97	27.96 $\pm$ 74.36
<b>Residence</b>	m	m	m	m
Rural	361.08 $\pm$ 418.89	368.76 $\pm$ 339.09	1.65 $\pm$ 1.02	41.14 $\pm$ 100.5
Urban	309.62 $\pm$ 331.21	326.65 $\pm$ 324.04	1.73 $\pm$ 1.09	16.46 $\pm$ 45.68
<b>Work duration (years)</b>	m	m	m	m
<15	332.9 $\pm$ 328.68	348.1 $\pm$ 346.36	1.65 $\pm$ 1.02	25.55 $\pm$ 73.28
$\geq$ 15	344.6 $\pm$ 427.19	353.21 $\pm$ 321.98	1.71 $\pm$ 1.08	34.94 $\pm$ 89.72
<b>Shift duration (hours)</b>	m	m	m	m
6	146.25 $\pm$ 99.78	318.75 $\pm$ 388.34	1.5 $\pm$ 0.58	8.44 $\pm$ 11.1
8	343.94 $\pm$ 387.1	351.64 $\pm$ 332.3	1.69 $\pm$ 1.06	31.13 $\pm$ 83.33
<b>Number of shift work</b>	k	k	k	k
1	201.25 $\pm$ 242.33	325 $\pm$ 228.86	1.81 $\pm$ 1.61	15 $\pm$ 42.54
2	299.04 $\pm$ 367.01	289.89 $\pm$ 276.14	1.44 $\pm$ 0.73	19.92 $\pm$ 77.43
3	372.01 $\pm$ 400.87	380.26 $\pm$ 361.53	1.78 $\pm$ 1.08	37.02 $\pm$ 87.52
<b>Nature of work</b>	***k	***k	k	k
Scrubbing nurse	390.42 $\pm$ 404.03	389.11 $\pm$ 350.37	1.69 $\pm$ 1.04	33.16 $\pm$ 86.6
Circulating nurse	95.62 $\pm$ 87.44	253.12 $\pm$ 131.61	2.25 $\pm$ 1.77	21.09 $\pm$ 52.1
Anesthesia nurse	108.86 $\pm$ 98.11	148.18 $\pm$ 128.79	1.45 $\pm$ 0.67	18.12 $\pm$ 63.18
<b>Departments</b>	***k	***k	***k	***k
Emergency	379.74 $\pm$ 388.01	240 $\pm$ 190.26	2.16 $\pm$ 1.33	39.72 $\pm$ 65.31
General surgery	243 $\pm$ 275.21	523.12 $\pm$ 353.94	1.87 $\pm$ 1.01	32.34 $\pm$ 111.52
ENT	493 $\pm$ 275.7	284 $\pm$ 139.73	2.45 $\pm$ 1.47	2.5 $\pm$ 1.7
Obstetrics & gynecology	338 $\pm$ 257.44	321 $\pm$ 285.66	1.4 $\pm$ 0.51	2.67 $\pm$ 1.82
Urology	198.4 $\pm$ 297.06	409.67 $\pm$ 341.04	1.97 $\pm$ 1.04	90.17 $\pm$ 141.0
Ophthalmology	450 $\pm$ 482.12	414.17 $\pm$ 336.87	1.58 $\pm$ 0.99	4.58 $\pm$ 6.05
Neurosurgery	228.43 $\pm$ 256.68	471.43 $\pm$ 484.22	1.36 $\pm$ 0.53	31.34 $\pm$ 74.12
Cardiothoracic	471.82 $\pm$ 452.56	676.36 $\pm$ 472.32	1.14 $\pm$ 0.45	2.61 $\pm$ 1.72
Orthopedic	510 $\pm$ 581.42	258.54 $\pm$ 296.09	1.41 $\pm$ 1.22	66.65 $\pm$ 118.66
Anesthesia	108.86 $\pm$ 98.11	148.18 $\pm$ 128.79	1.45 $\pm$ 0.67	18.12 $\pm$ 63.18

\*\*\*: Statistically significant at  $p<0.001$

m: Mann-Whitney test;

k: Kruskal Wallis test

Table (4) showed that the risk of exposure to blood and body fluids and to encounter nosocomial infections was significantly higher among scrubbing nurses compared to circulating and anesthesia nurses ( $p<0.001$ ). There was significant difference between nurses working at the different departments regarding exposure to blood and body fluids, nosocomial infections and spontaneous miscarriages ( $p<0.001$ ). The highest score was among nurses who were working at the Orthopedic, Cardiothoracic and Urology departments respectively.

**Table (5) Differences in operating rooms ergonomic, psychosocial and organizational hazards risk scores by demographic characteristics and work situations of the studied nurses.**

Ergonomic, psychosocial and organizational hazards risk scores Variables	(Mean ±SD)		
	Fatigue and chronic muscular-skeletal pain	Psychological stress	Stress, strained family relations, and burnout
<b>Age (years)</b>	m	m	m
<32	163.61±201.42	38.15±55.36	16.48±37.57
≥32	167.33±243.82	39.26±114.63	26.56±52.62
<b>Residence</b>	m	m	m
Rural	176.74±225.29	44.27±110.7	19.63±41.81
Urban	150.31±221.36	31.2±50.83	24.29±51.29
<b>Work duration (years)</b>	m	m	m
<15	171.04±205.66	37.98±56.98	16.1±37.76
≥15	160.77±238.47	39.35±111.44	26.33±51.76
<b>Shift duration (hours)</b>	m	*m	m
6	142.5±75	99±93.53	62.25±82.75
8	166.07±225.82	37.24±89.95	20.62±44.71
<b>Number of shift work</b>	k	k	k
1	150±182.88	63.96±146.11	66.46±85.43
2	148.34±235.85	33.35±47.97	17.95±38.75
3	174.69±223.14	38.25±96.79	18.23±40.53
<b>Nature of work</b>	*k	k	k
Scrubbing nurse	176.8±230.88	40.38±96.96	19.33±42.15
Circulating nurse	73.75±93.42	7.94±9.61	54.25±80.11
Anesthesia nurse	128.5±201.74	39.57±55.6	23.98±51.29
<b>Departments</b>	***k	k	k
Emergency	84.47±69.3	28.47±42.03	21.47±44.02
General surgery	333.19±345.29	89.69±220.73	35.97±58.67
ENT	220.67±244.64	61.67±129.4	30.5±61.32
Obstetrics & gynecology	120.6±147.87	24.2±30.34	4.07±3.64
Urology	168±218.2	45.9±70.27	9±22.87
Ophthalmology	211.17±339.43	32.89±55.53	27.58±45.86
Neurosurgery	121.07±75.91	20.48±47.49	29.25±64.0
Cardiothoracic	223.64±244.96	25.68±52.52	27.95±56.79
Orthopedic	103.68±106.78	21.89±37.75	10.53±23.67
Anesthesia	128.5±201.74	39.57±55.6	23.98±51.29

\*,\*\*: Statistically significant at  $p<0.05$ ,  $p<0.01$

m: Mann-Whitney test;

k: Kruskal Wallis test

Table (5) showed that the risk of fatigue and chronic muscular-skeletal pain due to handling patients and to prolonged standing was significantly higher among scrubbing nurses ( $p<0.05$ ). Also, chronic muscle pain was more likely among nurses who were working in the General Surgery department followed by other departments ( $p<0.01$ ). The risk of psychological stress due to heavy work was more likely among nurses with shift duration of six hours.

### **Discussion**

This study is the first study on ORNs in Qualubeyia governorate, as far as the author knows. The study aimed to assess the risk of adverse health effects related to OR occupational hazards among ORNs in Benha University Hospitals. Due to the complex nature of the OR, ORNs encounter series of hazards that are categorized into biological, chemical, physical, and psychosocial hazards.

As regard physical hazards, radiation was considered as a high risk according to Fine risk prioritization matrix in the presented study (Table 1) with the highest score was among anesthesia nurses and nurses who were working at the Orthopedic department (Table

2). This high risk of radiation among Anesthesia and Orthopedic departments nurses could be due to deficits in their knowledge about radiation hazards, and lack of training about how to protect themselves. They do not wear personal protective equipment (PPE) during radiation settings because they are uncomfortable and heavy. The increased risk of exposure to radiation among OR nurses was also reported by a cross-sectional study among 21,095 nurses working at 100 hospitals across Taiwan. They reported that OR and intensive care unit nurses were exposed to the highest levels of radiation compared with all nurses ( Chiou et al, 2013). Also Ugurlu et al.,2015 on their study on the effects of workload and working conditions on operating room nurses and technicians stated that over 71% of ORNs reported health problems related to radiation exposure.

Acute muscle pain due to awkward body position and overextension when handling patients was categorized as a significant risk according to the used Fine risk score (Table 1). The nursing profession was ranked second after industrial work as far as physical work load was concerned (Gholami et al., 2016). Routine work of OR, for

example, patient-handling tasks, are the main causes of shoulder injuries and back pain. Also, working in an awkward position and long-time standing could be a risk factors (Walton and Rogers, 2017).

National Institute for Occupational Safety and Health (NIOSH) mentioned that, fall is a persistent hazard found in all occupational setting (NIOSH, 2016). Nurses are closer to blades and other invasive instruments, open wounds, blood and various body fluids which raise the risk of accidental sharp injuries. These reasons might explain the high possibility of work-related physical disorders among scrubbing and circulating nurses. But, in this study sharp objects injury risk score was very low (Table 1). This might be due to underreporting of injuries. This is not compatible with previous studies, which stated that nurses working in ORs and emergency and intensive care units were found to be at the highest risk for needle stick injuries (Chiou et al., 2013, and Ugurlu et al., 2015).

Exposure to various anesthetic drugs and gases might be responsible for headache, dizziness and mucous membrane irritations. OR nurses are usually exposed to low concentration

but long-lasting anesthetic medications. The National Institute of Occupational Safety suggested that OR nurses are at risk of anesthesia exposure even when the OR is provided with scavenging equipment (NIOSH, 2007). This agreed with the present study which reported a significant risk (Table 1). The risk increased among nurses working in ENT department (Table 3) as their field of work is near to anesthetic equipment. The high percentage of complaints related to anesthetic gases by the OR nurses in this study could lead to the conclusion that the evacuation of anesthetic gases from the ORs at Benha University Hospital was not adequate. These results could be also attributed to that work overload in addition to lack in implementation of job training program to teach the staff on how to commit with using protective equipment during dealing with chemicals and how to protect themselves from its complication. Our results were similar to that was detected by Nouetchogou et al., 2016 in their study on accidental exposures to blood and body fluids among health care workers in a Referral Hospital of Cameroon.

In our study, latex allergy was categorized as a significant risk

according to risk prioritization matrix with the highest score was among nurses working in ENT and General Surgery departments (Table3). Latex allergies are common because most individuals did not report any allergy in the past to higher authorities so latex not substituted by another non latex gloves or synthetic rubber gloves.

A cross-sectional study of 501 health personnel using hypoallergenic latex gloves at King Edward VIII Hospital in KwaZulu-Natal, South Africa, reported that 5.9% to 7.1% who had been exposed to latex and 1.8% to 3.1% who had not been exposed to latex were determined to be sensitive or allergic to latex (Phaswana and Naidoo,2013).

Biological risk of blood and body fluids total score was high (Table 1). A lot of blood and body fluids splashes occur in OR. OR air carries high risk of inhalation of organisms if cases are septic. In the current study, the highest score was among scrubbing nurses and nurses who were working at the Orthopedic department (Table 4). This can be due to scrubbing nurses, surgeons' assistants, and orthopedic surgeries are bloody operations with long working hours. It was reported that 90.5 % of ORNs were exposed

to splashing of blood or body fluids (Nouetchognou et al.,2016).

The risk of contracting a nosocomial disease as a result of a prick from a syringe needle was high (Table 1). The highest score was among scrubbing nurses and nurses who were working at the Cardiothoracic department (Table 4). These results could be attributed to the absence of awareness of infection control rules that guided them to how to protect themselves from exposure to biological hazards or while recapping the needle or when dealing with sharp objects. This could be also due to lack of orientation to safety protocols and protective measures. A literature search revealed differing rates of sharps injuries among OR personnel. For example, a retrospective study of 164 OR staff in Japan reported that 82% had been injured by sharp objects, including 64% of surgeons and 36% of nurses (Nagao et al.,2009).

Musculoskeletal workplace hazards are collectively known as workplace traumatogens. In the current work fatigue and chronic muscular-skeletal pain risk score was a significant risk according to Fine risk score (Table 1). The highest score was among scrubbing nurses and nurses who

was working in the General Surgery department (Table 5). Scrubbing nurses require more physical power than anesthesia nurses in terms of lifting and transferring of heavy materials and tools in surgery preparations and assisting surgeons during the surgery in a static for example standing posture or holding an instrument still for long hours. Correspondingly, a study of 159 ORNs working in Gaza hospitals, found that 70.6% of the nurses had lumbar pain (Aljeesh and Al Nawajha,2011). Similarly, 78.1% out of 80 ORNs in Nigeria had lumbar pain after they began working in the profession (Hinmikaiye and Bamishaiye,2012).

The current study showed that psychological stress caused by feeling of heavy responsibility towards patients, strained family relations, and burnout were possible risks according to Fine risk score (Table 1). These results may be due to excessive workloads and the stressful work environment. The inadequacy of precautions which contributes to the high levels of accidents and health problems among OR nurses increases level of stress(Gorgich et al,2016). Along with this, it was found that most of the ORNs defined their work environments as either stressful

or very stressful ( Table 1).

### **Conclusion and recommendations:**

The complex structure of ORs leads to increased occupational hazards which can affect ORNs' health. Further prospective studies are recommended to identify the effects of OR hazards on nurses' health. Several measures can be taken to reduce exposure to work-related hazards. Engineering control strategies have been designed to modify or eliminate the exposure source as regard anesthetic gases with well efficient ventilation .Also safe needle-stick devices and needle disposal containers should be available (ILO,2000).

### **Conflict of interest**

The authors declared that there is no conflict of interest exists.

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