

## Health Hazards and exposure indicators among onshore drilling workers: Neglected area needs an action

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### Abstract

**Background:** The oil and natural gas sector has a significant place in the world's economy. It increases the risk of work related fatality, injury and diseases.

**The aim:** of the present study was to assess occupational health hazards and exposure indicators among onshore drilling workers.

**Design:** A descriptive design was used.

**Setting and Sample:** Convenience sample of drilling workers were selected under the inclusion criteria (60 workers). The study was done in Egyptian drilling company in Kalbasha, Marsa Matrooh.

**Tools:** an interviewing questionnaire developed by the researcher to assess characteristics of workers, awareness of workers about health hazards found in their work place, the exposure indicators to occupational health hazards, awareness of workers about hazard control measures used in their company, and the level of workers' acceptance to health and safety activities applied in the company.

**The main results of the present study:** It showed that all studied workers reported chemical hazard one of the occupational health hazards found in their company, and 83.3% of them mentioned physical hazards, followed by ergonomic hazards 58.3% and psychosocial hazards 45.0%.

**Conclusion:** About one third of studied workers suffered from health problems related to exposure to occupational hazards in their work; they suffered from dermal, respiratory and musculoskeletal problems.

**Recommendation:** Effective health education programs and obligatory free training about hazards and safety measures should be provided to the workers.

**Keywords:** Occupational Health Hazards, exposure indicators, onshore, drilling workers,

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### I. Introduction

The oil and gas industry is one of the leading industries where a great portion of workforces are employed. Oil and gas sector has grown significantly over recent years, making it important for the sector to implement serious changes to work place to maintain safety of workers and prevent or reduce occupational injuries (Schneider et al., 2013). Onshore drilling relates to drilling deep holes under the earth surface in order to extract natural resources (usually oil and gas). There are two main types of onshore drilling: percussion, or 'cable tool' drilling, consists of raising and dropping a heavy metal bit into the ground, effectively punching a hole down through the earth. Cable tool drilling is usually used for shallow, low pressure formations. The second drilling method is known as rotary drilling, and consists of a sharp, rotating metal bit used to drill through the Earth's crust. This type of drilling is used primarily for deeper wells, which may be under high pressure (Onwukwe and Nwakaudu (2012)). There are two primary types of drilling fluids: Water Based Fluids (WBFs) and Non-Aqueous Drilling Fluids (NADFs) or Non-Aqueous Base Fluid (NABFs) (James et al., 2007).

The oil and gas industry has been cited as a major pollution source. (Eyayo, 2014). Workers are thus exposed to many and varied health hazards, accidents/injuries. A critical area of focus in the drilling process is the proper management and disposal of drilling fluids and waste products. Drilling wastes can include drilling mud, produced water, or other byproducts that can have a harmful impact on the environment in the event of an uncontrolled release. The containment and disposal of the wastes is a main priority (Arthur, et al., 2011). Therefore occupational health practice in the oil and gas industry must take more concern to the known hazards that exist in the particular locale of operation in order to prevent and control their occurrence. (Aliyu and Saidu, 2011). Occupational risks and hazards are the health problems that employees face in their work environment and how those health problems affect the health status of employee and their family (Aliyu and Auwal, 2015). Engineers in the drilling operation are exposed to chemical hazards including hydrogen sulfide (H<sub>2</sub>S), drilling fluids, silica, diesel exhaust, and mercury and physical agents such as radioactive sources, drilling mud and petroleum products. Due to handling of these petroleum products and oil field chemicals, they are affected by various diseases. Noise and vibrations also can cause adverse health effects such as hearing impairment and hypertension. Other dangers include confined spaces, in which untrained workers have been seriously injured or killed (Chamberland, 2015).

Workers in Oil and Gas industry are generally susceptible to following agents which lead to various health and illnesses hazards: chemical hazards (toxic, corrosive, carcinogens, asphyxiates, irritant and sensitizing substances); physical hazards (noise, vibration, radiations, extreme temperature); biological hazards (virus, parasites, bacteria); ergonomic hazards (manual handling activities, repetitive motions, awkward postures); and psychosocial hazards (overwork, odd working hours, isolated sites, violence)(**Chauhan, 2014**). The most common health effects observed from drilling fluids exposure are skin irritation, contact dermatitis and respiratory problems while headache, nausea, eye irritation, and coughing seen less frequently. The effects are caused by the physio-chemical properties of the drilling fluid, additives, human exposure to those components and dependent on the route of exposure such as dermal, inhalation, oral and others. Also, Hazardous fluids used during drilling could cause burns, explosions, violent chemical reactions, respiratory damage, physical injuries, trips, and falls.(j) Health effects depend on the intensity of the exposure, the duration of exposure, the organ affected and duration of exposure(**Bediako and Amorin, 2010**).

Safety of the employees is the top priority oil and gas industry where exploration activities carried out in deep and harsh environment with more sophisticated technology to meet the market demand increases the risk of employee health and safety (**Adebola, 2014**). Efforts to reduce injuries and illnesses, medical costs, and productivity losses and to improve overall morale are a critical part of these company operations. They must develop strategies for compliance with worker health and safety requirements. Also need strategies for meeting exposure standards. Drilling companies must take precautions that are necessary to limit workplace health and safety injuries and illnesses especially among the major areas of drilling fluid exposure: Shale shaker house, drilling floor, mud pit system, sack room, laundry services, and deck operations(**Bediako and Amorin, 2010**).

The occupational health nurse have major role in providing comprehensive health, wellness and safety services to the employee population in accordance with all applicable company policies, government regulations, nurse practice standards and best practice guidelines. In all areas of practice, the occupational health nurse will act as a resource and an advocate for both employee and company to encourage the attainment of optimal health and well-being within the corporation (**Harkness, Gail, and Rosanna, 2012**).

### **Significance of the study**

In Egypt, a large number of oil wells drilling companies are worked and large quantities of pollutants generated and till now the use of oil well drilling liquid waste has received comparatively little attention by researchers and engineers. Drilling engineers need to conduct comprehensive risk assessments of drilling fluid systems, considering all its associated problems. This risk assessment includes health aspects, environmental and safety aspects, to be able to strike an appropriate balance between them to minimize the exposure of drilling fluids to drilling operators, environmental effects and other related issues(**James et al., 2007**). Too many workers are dying in the oil and gas drilling industry. According to the Bureau of Labor Statistics (BLS), the oil and gas fatality rate in 2012 was 7.6 times higher in the USA than the all-industry rate of 3.2 deaths per 100,000 workers. These workers are engaged in many different industrial processes needed to successfully drill and service a well. These processes frequently expose the drilling workers to many occupational health hazards. Saving the lives of drilling workers depend on identifying and eliminating hazards and training oil and gas workers to control these hazards (**OSH Academy, 2016**). Therefore, this study aimed to assess Occupational Health Hazards and exposure indicators among onshore drilling workers.

### **Aim**

The aim of this study was to:  
Assess Occupational Health Hazards and exposure indicators among onshore drilling workers.

### **Research questions:**

- RQ1: What is the awareness of workers about health hazards found in their work place?
- RQ2: What are the exposure indicators to occupational health hazards?
- RQ3: What is the awareness of drilling workers about hazard control measures used in their company?
- RQ4: What is the level of workers' acceptance to health and safety activities applied in the company?

## **II. Methodology**

### **Research design:**

A descriptive design used to achieve the aim of the current study.

### **Research Setting:**

The study was done in Egyptian drilling company in Kalbasha, MarsaMatrooh.

**Research Sample:**

Convenience sample of drilling workers(60 workers) were selected under the following criteria:

- 1-Egyptian workers.
- 2-Affiliated to the company under study.
- 3-Accept to participate in the study.
- 4-Working at least one year in the study setting.

**Tools of Data collection:**

**Questionnaire was developed by the researcher after reviewing the related literature to assess:**

- **Characteristics of workers** that include; age, experience, training courses and occupation.
- **Awareness of workers about occupational health hazards found in their work place** that include all occupational health hazards about Physical, Ergonomic, Chemical, Psychosocial Hazards.....

**Scoring system:** items scored 1 for present answer and zero for absent.

- **The exposure indicators to occupational health hazards:** include all occupational health problems associated with the nature of work in drilling company as musculoskeletal problems, dermal, and respiratory problems.

**Scoring system:** items scored 1 for presence of health problem as exposure indicator and zero for absence of health problem.

- **Awareness of workers about hazard control measures used in their company:** include all control measures used in the company.

**Scoring system:** items scored 1 if the worker aware about hazard control measures used in their company and zero if not aware.

- **The level of workers' acceptance to health and safety activities applied in the company.**

**Scoring system:** items scored 1 for the workers' answered 'satisfied' and zero for the workers' answered 'unsatisfied'. The total score categorized as: if the studied workers agree about 60% and more of the items considered satisfied, and considered unsatisfied if the studied workers disagree about less than 60% of the items.

**III. Method**

Data collection extended from December 2014- April 2015

**Approval**

An official letter from the faculty of nursing was delivered to the director (s) of the intended study setting (company director). A full explanation about the aim of the study was explored. Official permission to conduct the study was obtained from the responsible authorities. Workers consent obtained before starting collecting data.

**Ethical considerations:**

The study was conducted with careful attention to ethical standards of research and rights of participants. Verbal consent was taken from each worker to participate in this study. During the initial interview, the purpose of the study and the procedures was explained to the workers. The subjects were assured that all information would be confidential and used for the research only to assure the confidentiality of the participants. The participation in the study was voluntary and that they can withdraw from the study at any time and can refuse to participate in the study. It would be explained that there were no costs to participate in the study.

**Data collection procedure:**

- The researcher asked the company medic (physician) to help her in data collection.
- After taking the agreement from the company medic to collect data, the researcher explained the aim of the study and provided more details about method of data collection, and provided more clarifications about the study subject.
- Tool developments: tools were developed by the researcher after reviewing the literature to collect the necessary data from workers. Tool validity test was done through five expertises from Menofia and Cairo University, faculty members of the Community Health Nursing Department. The internal consistency of the instrument has been tested using Cronbach's alpha coefficient (0.78).

**Pilot study:**

A pilot study was carried out on 6 workers to test the content of the questionnaire as well as to estimate the time needed for data collection and the necessary modifications was done. Those who shared in the pilot study were excluded from the study sample.

- The researcher communicated daily by electronic methods (E-mail, whatsapp, Facebook) with the company medic throughout the time of data collection to follow the procedure of data collection and provided any clarifications.
- Firstly the characteristics of workers that include; age, experience, training courses and occupation were collected, and they asked to check on the occupational health hazards found in their work place and if they affected by any of those hazards, and what are the occupational health problems associated with exposure to these hazards.
- Then the workers asked to check in front of hazard control measures used in their company, and asked if they satisfied about health and safety activities applied in the company or not.

### Results

**Table (1)** showed that 60.0% of the studied workers their ages ranged from 30 to less than 40 years old and minimal percentage of 13.3% their ages were 40 years and more. Concerning years of experience, more than two third (68.3%) of studied workers had years of experience exceed 3 years, in relation to occupation, 43.3% of studied workers were engineers, and 56.7% were drilling workers.

**Table (2)** revealed that all studied workers reported chemical hazard one of the occupational health hazards found in their company, and 83.3% of them mentioned physical hazards, followed by ergonomic hazards 58.3% and psychosocial hazards 45.0%.

**Figure (1)** illustrated that the majority of studied workers reported that they exposed to hydrogen sulfide (93.0%) and sodium hydroxide (90.0%) in their workplace and about one third (36.7%) of them mentioned that they exposed to sulphur dioxide (SO<sub>2</sub>).

**Table (3)** showed the rate of health problems among studied workers as a result of exposure to hazards; they suffered from musculoskeletal, dermal and respiratory problems. The highest percentages were for bronchitis 33.3%, followed by skin irritation 20.0%, asphyxia 16.6% and low back pain 11.6%.

**Figure 2** indicated that about one third of studied workers (36.6%) suffered from health problems related to exposure to occupational hazards in their work, most of studied workers who suffered from health problems were drilling workers 77.2% and 22.7% were engineers.

**Table (4)** showed that most of studied workers were aware about methods of hazards control used in their company, the highest percentages were for using alarm system; (90.0 % fire alarm, and 80.0% gas test), followed by fixed monitors (61.7% H<sub>2</sub>S sensors), and 56.7 for periodic inspection and blow out protective. The data showed that the awareness of engineers about methods of hazards control used were higher than drilling workers.

**Table 5** denoted that about two thirds of studied workers reported that they satisfied from the health and safety activities applied in their company. The highest percentage was for Pre-employment examination 80.0% and for Provide clear and announced health and safety instructions 70.0%

**Figure (3)** illustrated that studied workers mentioned their needs to protect themselves from health hazards as follow; all of them need training courses, and 20.0% reported that they need emergency exits, and escape unit, and 10.0% need building rescue unit.

**Table (6):** indicated that there were statistically significant differences between workers 'experience, occupation & periodic training courses and presence of health problems. Most of workers (70.7%) who had experience more than 3 years and most of engineers (80.8%) were free from health problems. Also more than two third of workers (69.8%) who attended periodic training courses were free from health problems, and 85.7% of those who didn't attend periodic training courses had health problems.

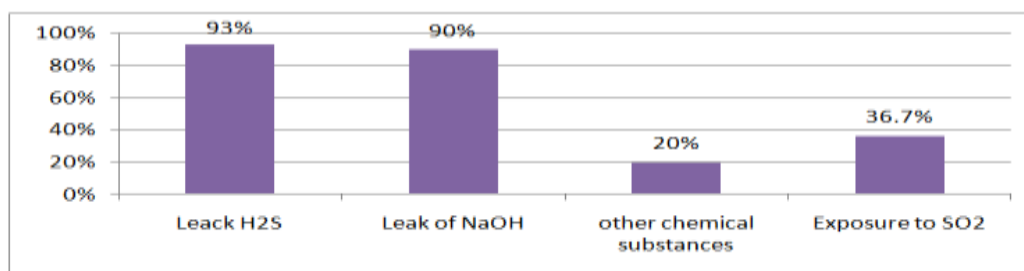
**Table (1): Distribution of studied workers according to their characteristics (n=60)**

Variables	Number	Percentage
<b>Age in years:</b>		
25-	16	26.7
30-	36	60.0
40-	8	13.3
<b>Years of experience</b>		
1-3years	19	31.7
>3years	41	68.3

<b>Training</b>		
• Received pre-employment training	25	41.7
• Received periodic training	53	88.3
<b>Occupation</b>		
Engineers	26	43.3
Drilling workers	34	56.7

**Table (2) Distribution of studied workers according their awareness about occupational health hazards found in their company (n=60)**

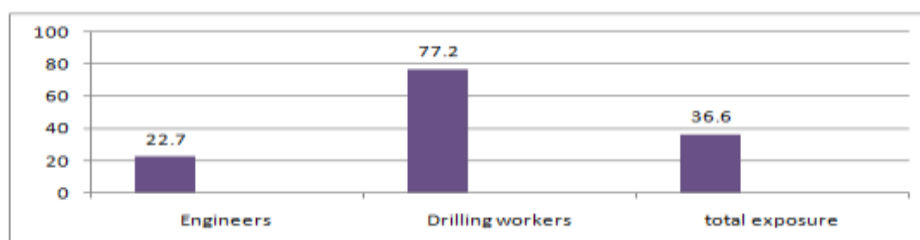
Items	No.	%
<b>Physical</b>	<b>(50)</b>	<b>(83.3)</b>
• Vibration	25	41.6
• Noise	40	66.6
• Heat	20	33.3
<b>Ergonomic</b>	<b>(35)</b>	<b>(58.3)</b>
• Repetitive work	15	25.0
• Lift heavy objects	5	8.3
• Stand for long type	30	50.0
<b>Chemical</b>	<b>(60)</b>	<b>(100.0)</b>
• H2S	58	96.6
• NaOH	54	90.0
• Amonia	6	10.0
• SO2	24	40.0
• Lime	8	13.3
• Chlorine	4	6.6
• Methyl alcohol	6	10.0
<b>Psychosocial Hazards</b>	<b>(27)</b>	<b>(45.0)</b>
• stressful condition	25	41.6
• work in isolation	15	25.0
• faced with some aggression	10	16.6



**Figure (1): Distribution of studied workers regarding their exposure to occupational health hazards in their company (n= 60)**

**Table (3): Distribution of studied workers according their health problems related to exposure to hazards (n=60)**

Health problems related to exposure to hazards	No	%
<b>Musculoskeletal problems</b>		
• Low back pain	7	11.6
• Neck complains	5	8.3
• Shoulder pain	3	5.0
<b>Dermal</b>		
• Skin burn	5	8.3
• Skin irritation	12	20.0
<b>Respiratory problems</b>		
• Bronchitis	20	33.3
• Asphyxia	10	16.6



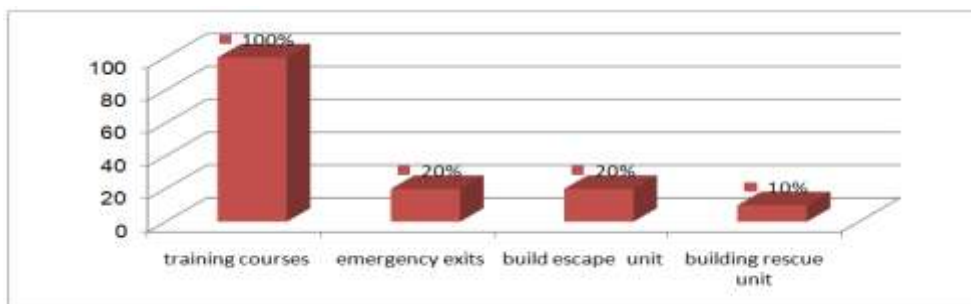
**Figure 2: Distribution of studied workers according presence of health problem due to hazards' exposure (n=60)**

**Table (4):Distribution of studied workers according to their awareness about hazard control measures used in their company**

Hazard control methods	Engineers (26)		Drilling workers (34)		Total (60)	
	No.	%	No.	%	No.	%
Periodic inspection	24	85.7	10	29.4	34	56.7
Blow out protective	26	100	8	23.5	34	56.7
<b>Alarm system</b>						
• Gas test	25	96.1	23	67.0	48	80.0
• H2S alarm	24	92.3	7	20.5	31	51.7
• High concentration of gases	23	88.4	9	26.4	32	53.3
• Fire alarm	26	100	28	82.0	54	90.0
<b>Fixed monitors</b>						
H2S sensors	26	100	11	32.3	37	61.7
<b>Portable monitors</b>						
H2S gas detector	21	80.7	6	17.6	27	45.0
Remotely operated shut off valves	19	73	5	14.7	24	40.0

**Table (5) distribution of the workers according to their evaluation to the health and safety activities applied in the company**

Activities	Satisfactory	
	No.	%
Perform regular inspection for work environment	36	60.0
Provide clear and announced health and safety instructions	42	70.0
Pre-employment entrance health examination	48	80.0
Conduct periodical medical examination	32	53.3
Update work instruction	34	56.6
Use adequate accident reporting system	40	66.7
Pre-employment training	25	41.7
Provide adequate training for the emergency plan	38	63.3
Provide all protective measures needed	40	66.7
The supervisors concerned with health and safety	38	63.3
<b>Total</b>	<b>(38)</b>	<b>(63.3)</b>
<b>Engineers</b>	<b>22</b>	<b>53.7</b>
<b>Drilling workers</b>	<b>16</b>	<b>39.0</b>



**Figure (3):Distribution of workers according their needs to protect themselves from health hazards**

**Table (6) The relation between workers’ characteristics and presence of health problems**

workers’ characteristics	Presence of health problems		Free of health problems		X <sup>2</sup>	p
	No	%	No	%		
<b>presence of health problem</b>						
<b>Years of experience:</b>						
- Less than 3years (19)	10	52.6	9	47.4	3.052	0.080
- More than 3years (41)	12	29.3	29	70.7		
<b>Occupation:</b>						
- Engineers (26)	5	19.2	21	80.8	6.007	0.014
- Drilling workers (34)	17	50.0	17	50.0		
<b>Training:</b>						
- Attended periodic training courses (53)	16	30.2	37	69.8	8.209	0.0042
- Didn’t attend periodic training courses (7)	6	85.7	1	14.3		

#### **IV. Discussion**

The oil and gas industry is rapidly expanding, providing many new jobs, but also increasing the risk for work-related fatality, injury and illness. Workers exposed to many health hazards that challenge the industry to maintain a safe and healthy work environment. The industry, federal agencies and occupational health and safety researchers should work together to examine and improve health and safety for workers (**Witter et al., 2014**) Therefore this study was aimed to Assess Occupational Health Hazards and exposure indicators among onshore drilling workers.

##### **RQ1: What is the awareness of workers about health hazards found in their work place?**

Regarding awareness of studied workers about occupational health hazards found in their work place. As reported by the workers, the results of current study revealed that they were susceptible to the following health hazards: physical hazards (vibration, noise and excessive heat or cold), chemical hazards (H<sub>2</sub>S and NaOH, ammonia, lime, and chlorine), ergonomic hazards (standing for long time, repetitive work & lifting heavy objects), and psychosocial hazards (stressful condition, work in isolation and aggression in work place). In the same line **Adebola (2014)** in study titled with knowledge, attitude and compliance with occupational health and safety practices among pipeline products and marketing company staff in Lagos, revealed that the staffs were able to identify various hazards available in the depot, they included Physical such as excessive heat or cold, light humidity, radiation and noise. The chemical hazards as lead, mercury, benzene and petroleum fumes. Psychosocial relationships which included worker-worker and worker-management relationships, long hours of work and workers' consideration in formulating company's policy.

The percentages of the current study results related to awareness of studied workers about occupational health hazards found in their work place were higher than of **Eyayo (2014)** who evaluated the occupational health hazards among oil industry workers in Nigeria and **Asikhia & Emenike (2013)** who studied occupational health and safety in the oil and gas industry in Nigeria and also **Cesar-vaz et al. (2012)** who studied Risk Perception and Occupational Accidents among Gas Station Workers in Southern Brazil. They revealed that the participants identified the following risk types: Physiological risk, who most frequently identified inappropriate posture and repetitive stress. Chemical risks included gases and fluids. Physical risk as vibration and noise and psychological risk including stressful situations. The higher percentages of present study might be due to more than two third of the studied workers had experience more than three years, most of them received training courses and 43.3% of them were engineers who must be aware of the hazards that might put them at risk during their work. While the percentage of ergonomic hazard in current study was lower than of **Cesar-vaz et al.** because gas station workers' main health complaint was the need to stay in a standing position all day.

##### **RQ2: What are the exposure indicators to occupational health hazards?**

The results of current study indicated that about one third of studied workers suffered from health problems related to exposure to occupational hazards in their work, most of studied workers who suffered from health problems were drilling workers; they suffered from dermal, respiratory and musculoskeletal problems. The highest percentages of complains were for bronchitis, followed by skin irritation, asphyxia and low back pain. On the same line **Chineke et al. (2016)** who studied occupational hazards among workers in petroleum-allied industries in Nigeria mentioned that several occupational hazards have been identified amongst the workers of the petroleum based industry, that resulted in many occupational health problems like cough, catarrh, burns and trauma are also identified. As regards to musculoskeletal problems, the current study results revealed that studied workers suffered from low back pain, neck pain and low percentage suffered from shoulder pain. These percentages were lower than of **Borayek, El-Toukhy and Abd El Azeem (2011)** who studied impact of onshore oil drilling works on musculoskeletal system and quality of life among a group of Egyptian drilling workers, they revealed that 31.9% for low back pain, 15.2% for neck and 28.3% for shoulder pain. The differences might be related that 43.3% of current study sample were engineers, they had lower exposure to ergonomic hazards than other workers.

Regarding respiratory problems, the results of current study revealed that 16.3% suffer from bronchitis and 33.6% suffered from asphyxia. In the same line **Minov et al. (2010)** who studied respiratory and nasal symptoms, immunological changes and lung function among petroleum refinery workers, reported that workplace exposure among petroleum refinery workers may lead to respiratory and nasal symptoms and lung function impairment. Related to dermal problems the result of current study showed that one third of studied workers suffered from skin irritation. In the same line **Bediako and Amorin (2010)** who studied the effects of drilling fluid exposure to oil and gas workers presented with major areas of exposure and exposure indicators in Ghana reported that when drilling fluids are circulated in an open system with agitation, there is a high likelihood of dermal exposure resulting in dermatitis and skin irritation.

### **RQ3: What is the awareness of drilling workers about hazard control measures used in their company?**

The present study results showed that the studied workers were aware about methods of hazards control used in their company, the highest percentages were for using alarm system; (fire alarm, and gas test), followed by fixed monitors (H<sub>2</sub>S sensors), periodic inspection and blow out protective. The awareness of engineers about methods of hazard control used were higher than drilling workers. This due to nature of their work and responsibilities in company. These results supported by **Henson and Jonathan Wade (2013)** who conducted study titled; safety on a drilling rig and safety culture, reported that all workers were aware about safety measures in the company. On the same line **Bassey (2012)** conducted study about compliance of staff with hazard control methods in a public and private petroleum depot in Nigeria, mentioned that the majority of petroleum workers had a high level of awareness about hazards control in the depot.

### **RQ4: What is the level of workers' acceptance to health and safety activities applied in the company?**

The results of current study showed that about two thirds of studied engineers satisfied from the health and safety activities of the company. In the same line **Eyayo (2014)** indicated that the occupational health and safety practices has been acknowledged to be effective by the workers (78.9%). Additionally **Elssayed, Hassan and Hosny (2012)** assessed the occupational level of awareness for health and safety in Sidikerir petrochemical company, they mentioned that the high percentage of workers agree that the performance of the company on various health and safety activities is good. Regarding the relation between workers' characteristics and presence of health problems, the results of the present study indicated that there were statistically significant differences between workers' experience, occupation & periodic training courses and presence of health problems. Most of workers who had experience more than 3 years and most of engineers were free from health problems. Also more than two third of workers who attended periodic training courses were free from health problems. On the same line **Martinovich (2013)** studied factors influencing the incidence rates of injuries and accidents among seafarers and rig workers providing support to the WA offshore oil and gas industry, he mentioned that there was an association between training, education and experience and injuries in oil and gas environment, as workers being injured were predominantly unskilled. **Keller, Associates, and Inc (2015)** added that training plays an important role in protecting workers from the identified hazards. Effective safety and health training is needed to make sure employees (including contract workers) understand the hazards to which they may be exposed and how to prevent harm to themselves and others.

## **V. Conclusion**

The results of current study revealed that the studied workers were susceptible to the following health hazards: physical, chemical, ergonomic and psychosocial hazards. About one third of them suffered from health problems related to exposure to occupational hazards in their work; they suffered from dermal, respiratory and musculoskeletal problems. They were aware about methods of hazard control used in their company and three fourth of them were satisfied from the health and safety activities applied in the company.

## **VI. Recommendations**

From the above findings, the following recommendations are made:

- Effective health education programs and obligatory free training courses about hazards and safety measures should be provided to the workers.
- Supervision to the workers to comply with hazards control methods.
- Further researches on Egyptian drilling workers are needed.

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