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Assessing the common occupational health hazards and their health risks among oil and gas workers

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ABSTRACT

The workplace's burden remains a significant concern to workers in the oil and gas industry, where workers are continually exposed to various kinds of occupational risks. The study aimed to identify the different health hazards and their sources across the oil and gas industry to determine the risks associated with health hazards. Methods: A qualitative approach was employed to identify the different hazards connected with the operational environment. A total of 1000 questionnaires were distributed randomly across the various departments in the Nigerian oil and gas industry, and 327 returned to the research team. Analysis of data was carried out using the SPSS. Results: The result shows that ergonomic hazards were found to be most predominant among the hazards assessed in the industry. Ergonomic hazards are 30%, physical hazards 26%, chemical hazards 23%, psychosocial hazards 18%, and biological 3%. Conclusion: Considering the aims of this study, the hazards that exposed workers to ill-health were identified with their sources in the oil and gas operational environment. Some of the health hazards were identified to have short-term health effects on workers, such as headaches, skin burn, eye and skin irritation, and rashes. In contrast, musculoskeletal disorders, respiratory disease, leukaemia, asphyxiates, hypertension, and cardiovascular disease are long-term health effects caused by other hazards. Recommendations: Adequate supervision should be imposed on the workers in their workplace, proper hazards assessment should be conducted in the industry, and compulsory medical testing should be carried out on workers always to know their health status.

1. Introduction

Workplace hazards remain a significant concern for workers in the oil and gas industry, where workers are continuously exposed to different forms of occupational hazards. It is believed that the oil and gas working environment is one of the most dangerous working settings (Ron, 2003). However, the industry poses various occupational risks due to numerous process activities (Eyayo, 2014). Globally, 2.9 billion workers are exposed in their workplace to risk threats. There are also two million deaths annually attributed to occupational diseases and injuries, and 4% of gross domestic product (GDP) - is lost due to occupational illnesses and injuries (Meswani, 2008).

In the 2000 World Health Organization survey, it was concluded that 37% of workers suffer from back pain, 16% from hearing illness, 13% from chronic obstructive pulmonary disease, 11% from asthma, 10% from trauma, 10% from lung cancer, and 2% from leukaemia are responsible for occupational hazards globally. It is still estimated by the International Labour Organization (ILO) that 2 million workers die per year from work-related occupational diseases. However, the rate of work-related accidents and injuries varies across countries, depending on the level of industrial development. In particular, developing countries continue to record tremendous losses in work-related occupational accidents, diseases more than the developed countries. (Kheni et al., 2008, Zheng et al., 2010, Takala et al., 2012, Demba et al., 2013).

Nigeria falls within these developing countries that experience more than 100 occupational deaths, and billions of capital losses have been recorded for 2009 and 2010 only due to occupational challenges (Ngwama, 2016). The industry has contributed significantly to the country's economy and the nation's energy needs. Therefore, occupational health management and practice in the Nigerian oil and gas industry must consider the hazards within the operational environment in order to prevent future risks that will significantly impact the well-being

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of the workers (Ngwama, 2016). To the best of our knowledge, no recent research has been performed in assessing the common occupational health hazards and their health risks among oil and gas workers in Nigeria. Identifying the various hazards threat emanated from the industry will be an effective way to control them and avoid more health effects. Thus the aim of this study was:

- To identify the different health hazards and their sources across the oil and gas industry
- To determine the risk associated with the health hazards, to provide recommendations in managing the risks emanated from the operational environment.

2. Overview of occupational hazards and their effects on workers

This study focuses on assessing the common occupational health hazards and risks in the oil and gas industry. This concept needs to be considered within the general framework of the occupational well-being of workers. Occupational health hazards generally differ from those found in the general environment. Thus, because workers are often exposed to confined spaces, the workplace's hazard exposure levels are usually higher than those exposed to hazards in the general environment (Hassim & Hurme, 2010). An occupational hazard is the hazards workers experienced in their workplace. In general, workers in the oil and gas industry are exposed to occupational hazards such as chemical, physical, biological, ergonomic, and psychosocial hazards (Chauhan, 2014). Occupational hazards can be categorised into two groups: safety hazards type that causes accidents, which result in physical injury to workers, and health hazards type, which results in the development of the disease (Donoghue, 2004).

The health effects on workers exposed to those hazards depend on the exposure's level, intensity, exposure duration, and the organ exposed to particular hazards. Thus, it will determine the level of health challenge the worker will develop (Bediako & Amorin, 2010). It is important to understand that a "hazard" only constitutes the potential to harm. Harm depends on the circumstances of toxicity of the health hazard, the amount of exposure, and duration. Risks involve can also be estimated according to the severity of the damage they cause (Smith et al., 2003). See Fig. 1 occupational hazards and their sources in the oil and gas industry.

2.1. Chemical health hazards

Chemical usage in oil and gas has an adverse high health effect on workers. Although this is not surprising, many chemical substances are associated with this industrial sector's activities. Either as exploration or production stage (as gathered in the material safety data sheet (MSDS),

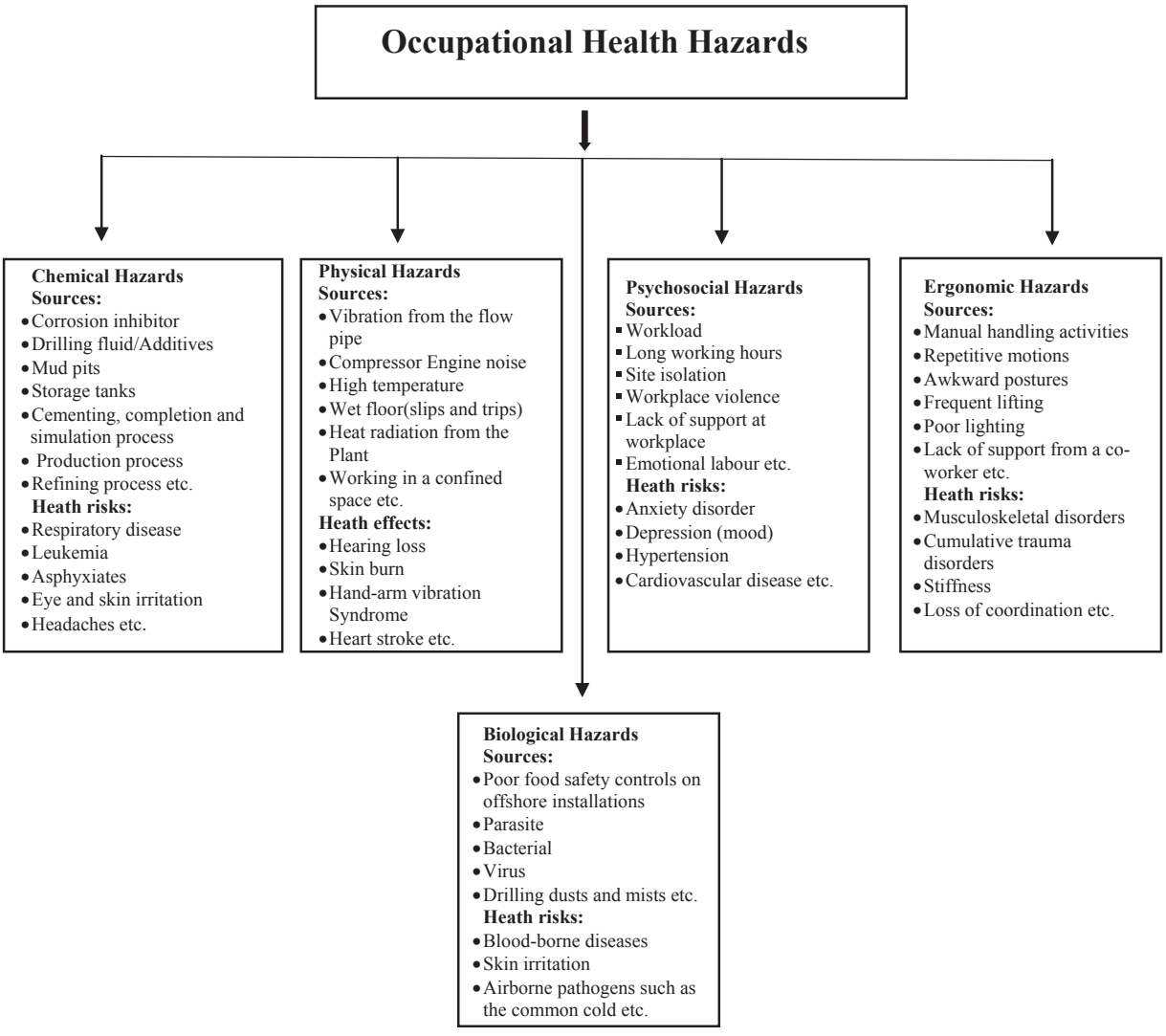

Fig. 1. Occupational health hazards sources and health risks.

products, or part of the discharged effluents in the form of solids, liquids, solvent, gases, mists, vapours and fumes, i.e., fuels and welding fumes, oil spills, flammable and explosive substances.

Human health is influenced by all the behaviours of a person exposed to a continuum of chemical exposure in the natural environment, including air, water, and soil, no matter the circumstance of touch (which may be recreational, residential, or occupational), (WHO, 1993). Chemical exposure in the workplace is almost exceptionally higher than that of the general population in another environment (Duarte-Davidson et al., 2001). Thus, the adverse effect of chemicals is most likely to appear in the workplace.

Workers exposure to chemicals may cause disease in many ways such as a specific disease may result directly from exposure to a particular chemical compound, exposure to a chemical may be only one of several factors attributing to the development of a disease, and part of a multi-causal relationship (Tsuchiya, 1978). The health effects of workers exposed to chemical toxicity include organ system damage, e.g., liver, kidneys, bones/joints, gastrointestinal tract, respiratory system, brain and nervous system, and blood-forming system, acute poisonings, reproductive failures, and terata, cancers, allergic reactions and also the cause of the deterioration of the environment (Aitio, 2003). Some of these effects are instant and acute; others may be delayed and result in chronic situations, while others have long term effects such as sterility, mutations, and congenital disabilities (World Health Organization (WHO), 1983).

2.2. Physical health hazards

The dynamic nature of work in the oil and gas industry continually involves offshore and onshore. Workers exposed to several hazardous conditions in the physical work environment include noise, vibration, explosions, fire, heat, high pressure, high vacuum, ionizing radiation, slips, and trips, causing injury and harm to workers' lives and after. In turn, these hazards can cause or lead to accidents that differ across the oil and gas industry and involve blowout of drilling fluid, gas explosion, falls from height, electrocution, and mobile equipment accidents in the drilling rig (Donoghue et al., 2000).

Noise-induced lead to hearing loss; vibration leads to the syndrome, such as vascular, neurological, and musculoskeletal disorders. Vibration and noise militate against health generally. However, these exposures are links to various physiological and psychological health effects, such as annoyance, sleep disturbances, electroencephalographic changes, and cardiovascular disorders (Morrell et al., 1997).

It has been shown that ionizing radiation, such as cosmic radiation, induces double-stranded DNA, which influences genomic instability in human chromosomes (Lim, 2002). The heat produced from the production engine and work stress has metabolic heat in the body, the temperature being in proportion to work intensity. The environment and physical factors and age, sex, physical fitness, health status, clothing, and acclimatization may be significant factors contributing to the changes occurring in the human physiological response to heat stress, i.e., heat strain (Beshir, 1994). The workplace's heat is also associated with diminished vigilance, heat-stroke, heat-related cramps, rashes and collapse, and exhaustion caused by water and salt depletion (Negash, 2002).

2.3. Psychosocial health hazards

Psychosocial hazards are obtainable in the oil and gas industry. However, the threat stems from overloaded work pressure, prolonged hours of work, shift work or call duty schedules and in some cases, monotony/boredom that can be done with repeated plans in some sectional operations (International Labour Organization (ILO), 1986). Workload has many physiological, psychological, and social consequences that lead to disturbances in the normal sleep-wake cycle, burnout syndromes, and depression (Korneeva et al., 2013). Site isolation or excessive responsibility for human or economic concerns can also have adverse psychological effects (Wadsworth et al., 2003).

The epidemiological evidence exists of an elevated risk of cardiovascular disorders, particularly coronary heart disease and hypertension, associated with workers' work stress (Steptoe & Kivimäki, 2012). Prolonged/extended working hours are, therefore, part of what is known as an "abnormal work plan" and it means working outside the 8-hour working duration specified by the work legislation of different countries (Working Time Directive) as harmonized by the International Labor Organization (ILO). More also, one of the physiological problems associated with Shift duty and the night shift, in specific, is that working, eating, and sleeping phases are changed. Workers who engage in shift duty or prolonged hours of work experience disrupting and keeping a distance from family, love one, and social activities may be likely affected by the low quality of sleep, fatigue, anxiety, depression, and increased neuroticism (Giovanni, 2010; Tobiasi, 2014).

2.4. Ergonomic health hazards

The oil and gas industry involves too many activities, from exploration to production process. However, workers are negatively associated with ergonomic hazards (Muhammad et al., 2019). Health problems that are involved with ergonomic; it as the result of interaction between the following conditions: the postures workers forced to adapt to reach, the manners workers operate the objects and equipment they work with, and the nature, time history of the utilization of force on those objects (Whitely & Plant, 2000).

In this technological era, most of the lifting and handling activities in the oil and gas industry are perform with the latest machinery or equipment. However, some tasks still need the human to executed has led the workers to exposure to ergonomic hazards (John et al., 2019). The health effects of workers exposed to ergonomic hazards include the musculoskeletal system and the upper limbs, neck, lower back cumulative trauma disorders, stiffness, etc. (Whitely & Plant, 2000). They are also associated with impaired visual function from visually demanding tasks over extended durations with inappropriate task lighting

2.5. Biological health hazards

The hazard is known as food-poisoning outbreaks, typical manifestations of biological hazards in the offshore or onshore operational environment. They are likely to occur more frequently, and often related to poor hygiene, associated with water dispensers, ice makers and ice cream machines. Galley space may also be limited, so cold storage can be insufficient. Airborne diseases can spread quickly through ventilation systems on offshore installations because accommodation is pressurized, and living space is typically at a premium (Punch, 2005). Robust health risk management is required to control health risks from potential Legionnaires' disease from water pipes' contamination, particularly in showers of accommodation blocks and air-conditioning plants (Karen & Ron, 2009).

In summary, it may-be said that anyone who wants to work in the oil and gas industry been local or international, off-shore or onshore, should be aware of facing the following hazards and agents, chemical hazards sources corrosion chemicals, drilling fluid/Additives, Production oil and gas well, refining process (petrochemical), physical hazards sources include vibration from the flow pipe, compressor engine noise, high temperature, wet floor (slips and trips), heat radiation from the Plant and working in a confined space, etc. Psychosocial hazards include workload, long working hours, site isolation, workplace violence, lack of support at the workplace.

Ergonomic hazards involved manual handling, repetitive motions, awkward postures, frequent lifting, low lighting, and lack of support from a co-worker. Biological hazards include poor food safety controls on offshore installations, parasites, bacterial, virus and drilling dust, and mists. Finally, the hazards lead to various health challenges, such as

respiratory disease, leukaemia, asphyxiates, eye, and skin irritation. Headaches, hearing loss, skin burn, hand-arm vibration syndrome, heart stroke, anxiety disorder, depression (mood), hypertension, cardiovascular disease. Musculoskeletal disorders, cumulative trauma disorders, stiffness, loss of coordination, blood-borne diseases, airborne pathogens such as the common cold, and respiratory illnesses (such as and digestive system disorders and ulcers, etc.).

3. Methodology

3.1. Sample and procedures

This research aims to identify the health hazards and their sources across the oil and gas industry. Data were collected through sampling from workers of the Nigerian oil and gas industry, which comprises workers across administrative positions and field workers in their various departments. Hence, questionnaires captured participants' age, years of experience and educational level, and other relevant information useful in the research subject. A validation review of the questionnaires was performed using experts in the research field, which evaluate the questions to see it covers or captured all the necessary information in the research. A pilot test was also carried out with 30 questionnaires and was found generally straightforward, readable, and could be completed relatively quickly. After the required assessment, the final questionnaires were distributed to a random sample of 1000 workers, with 27 operating stations operated by 19 different companies. A total of 327 questionnaires were completed and returned to the research team. Participants responded to all the questions using a 5-point Likert-type scale ranging from strongly disagree to strongly agree. See table 1. Finally, statistical analysis was carried out using SPPS to measure the percentage of the occurrence of those health hazards identified by workers in their various working environments.

4. Results

Descriptive statistics of the sample demographics of participants reveal that 91.13% of the respondents (327) were male, and 8.87% were female. Participant's age was at the range of 18–52, and above, work experience is between the range of 2 – 10 years. Above, the educational level of participants was a professional degree to doctoral degree or equivalent. See Table 2. A reliability test was performed on the data collected to determine adequacy and consistency. The result confirmed the data collected to be reliable at a consistency level of 0.70. Chemical hazards consist of 5 items with Cronbach alpha values of 0.85; Physical hazards comprise 7 items and a Cronbach alpha of 0.80. Psychosocial hazards are made up of 6 items with Cronbach alpha values of 0.82; Ergonomic hazards contain 6 items with Cronbach alpha values 0.90, and Biological hazards involve 5 items with Cronbach alpha values 0.70. $\alpha \geq 0.9$ = Excellent, $0.9 > \alpha \geq 0.8$ = Good, $0.8 > \alpha \geq 0.7$ = Acceptable, $0.7 > \alpha \geq 0.6$ = Questionable, $0.6 > \alpha \geq 0.5$ = Poor and $0.5 > \alpha$ = Unacceptable (Hair et al., 2003). The minimum acceptable Cronbach alpha value to accept that a measurement scale is reliable is 0.70. The attained Cronbach alpha values were at least 0.70, which means that they met the minimum prescribed threshold for construct reliability. Table 1 depicts the demographic information regarding the participants.

The evaluation of occupational hazards emanated in the oil and gas industry. The analysis results indicate that workers in the industry face more ergonomic hazards, which amount to 30%, followed by Physical hazards, 26%, chemical hazards 23%, and Psychosocial hazards 18%. Thus, the least among the hazards evaluated in the level of occurrence are biological hazards, which amount to be 3% in the research industry. See Fig. 2.

The risk impact analysis indicates that high musculoskeletal disorders are encountered by employees in the oil and gas industry, especially those working in operational and drilling departments. Some of the

Table 1
Research questions.

S/N	Research questions
	Chemical Health Hazards
Q1.	Do you agree that your job role is part of dealing with chemical substances?
Q2.	Do you agree that chemicals/gases are flammable, poisonous, and corrosive?
Q3.	Do you agree that harmful chemicals are sometimes inhaled, swallowed, injected, and spillover your skill?
Q4.	Do you agree that chemicals are likely to affect one health when exposed to them for a long time?
Q5.	Do you agree that exposure to chemical hazards could cause reproductive disorder, cardiovascular disease, respiratory disease, and kidney disease, etc.?
Q6.	Do you agree that the effect of chemical hazards can lead to loss of life?
	Physical Health Hazards
Q7.	Do you agree that the noise level in your workplace is relatively high
Q8	Do you agree that exposure to loud noise could lead to loss of hearing?
Q9.	Do you agree that your job function has to do with working with an object, tools, equipment, machine, chemical, etc., with a high temperature?
Q10.	Do you agree that excessive heat will contribute to body cramping?
Q11.	Do you agree that vibration will disturb the spine and cause fatigue?
Q12.	Do you agree that that inadequate lighting will affect the eyes?
Q13.	Do you agree that radiation can cause cancer and premature ageing of the skin?
	Psychosocial Health Hazards
Q14.	Do you agree that your workload is very challenging?
Q15.	Do you agree that you would like to be transferred to another unit/ department due to the lack of a corporation?
Q16.	Do you feel isolated from your working environment?
Q17.	Do you agree that sometimes you are being talked down by your Superior?
Q18.	Do you face any aggression and harassment in your working place?
Q19.	Do you know that Psychosocial hazards could cause hypertension, anxiety, boredom, etc.?
	Ergonomic Health Hazards
Q20.	Do you take an uncomfortable stance even when working?
Q21.	Do you work in height sometimes?
Q23.	Do you agree you stand for a long time when doing your work functions?
Q24.	Do you agree that your health could be compromised by manually lifting heavy objects?
Q25.	Do you work repetitively and monotonously when performing your task?
Q26.	Do you agree that ergonomic hazards may cause back, spine, and body discomfort?
	Biological Health Hazards
Q27.	Do you agree that certain substances containing microbes can be present in your working environment?
Q28.	Do you agree that while working, hazardous waste is generated?
Q29.	Do you agree that any of these hazardous wastes may have an effect on workers' health?
Q30.	Do you agree that tuberculosis, pneumonitis, pneumonoconiosis, etc., could be caused by biological hazards?
Q31.	Do you agree that your workplace lacks good environmental hygiene?

Table 2
Demographic Information of the Participants.

Variable	Frequency (N = 327)	Percentage (100%)
Gender		
Male	298	91.13
Female	29	8.87
Age		
18–30	67	20.5
31–42	172	52.6
43–51	76	23.2
52 and above	12	3.7
Educational level		
Professional Degree	34	10.4
Bachelor or Equivalent	211	64.5
Master or Equivalent	76	23.2
Doctoral or Equivalent	6	1.8
Work experience		
Less than 2 years	45	13.8
From 2 to 5 years	71	21.7
From 5 to 10 years	91	27.7
More than 10 years	107	32.7
Not an oil and gas worker	13	4.0

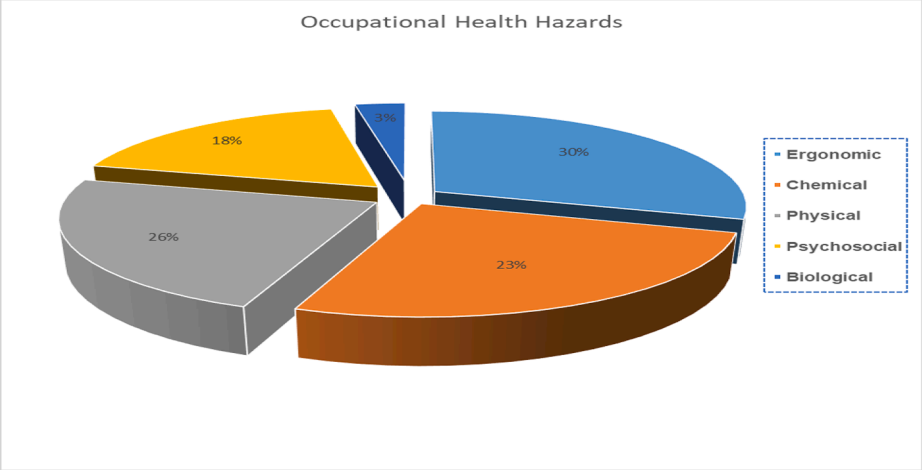

Fig. 2. Occupational health hazards in the oil and gas industry.

diseases are therefore identified to have short-term health effects on workers, e.g., Headache, Airborne pathogens (common cold), Eye irritation, skin irritation, and skin burn. In contrast, others have long-term effects on workers' health, such as Leukemia, respiratory disorder, hearing loss, hand-arm vibration syndrome, hypertension, etc. See Fig. 3

5. Discussion

This paper aims to identify the health hazards and their origins in the oil and gas industry and the health threats associated with workers. The study shows that 91.13% of male employees are more than 8.87% of females in the Nigerian oil and gas industry. Thus, this is not surprising considering the nature of the work involved in the industry. This is also aligned with the results in the analysis (Eyayo, 2014). The study found that workers accepted that they were exposed to various occupational hazards, which can be generally defined as chemical, physical, psychosocial, ergonomic, and biological hazards. Ergonomic hazards, which occur at 30%, are the highest incidence hazards identified by workers. Undoubtedly, ergonomic hazards result in diseases such as musculoskeletal disorders, cumulative trauma disorders, stiffness, and loss of coordination. This research outcome is in line with past studies (Whitely & Plant, 2000; John et al., 2019).

Among the workplace threats workers face in their operational environment, physical hazards were 26%. However, the hazard reported originating from the flow pipe's vibration, compressor engine sound, high temperature, wet floor (slips and trips), heat radiation from the Plant, and working in a confined space. Physical risks, such as hearing loss, skin burning, hand-arm vibration syndrome, and heart stroke, are associated with health effects. However, this study's findings are similar to the observation made by (Beshir, 1994, Donoghue et al., 2000, Lim, 2002). Chemical hazards, which contribute to 23% of the risks, are the other common occupational hazards affecting workers in the oil and gas industry. This study shows that corrosion agents, drilling fluid/additives, mud pits, storage tanks, cementing, completion and simulation processes, oil and gas well production, and refining processes are the origin of hazards. Health effects on workers are respiratory disease, leukaemia, asphyxiate, eye and skin irritation, headaches, and rashes etc. (Tsuchiya, 1978, Aitio, 2003).

Psychosocial hazards, often available in the oil and gas industry, arise from overloaded work pressure, site isolation, workplace violence, lack of support at work, emotional labour, prolonged hours of work, shift duty, or call duty schedules. In some cases, monotony/boredom obtainable in some sectional operations marked with repetitive plans. This hazard was 18%, contributing to workers with numerous health effects such as anxiety disorder, depression (mood), hypertension, and cardiovascular diseases. This study's findings are in line with the previous research of (Giovanni 2010; Steptoe & Kivimäki, 2012; Tobiasi, 2014). Finally, biological hazards are reported as the least 3% hazard

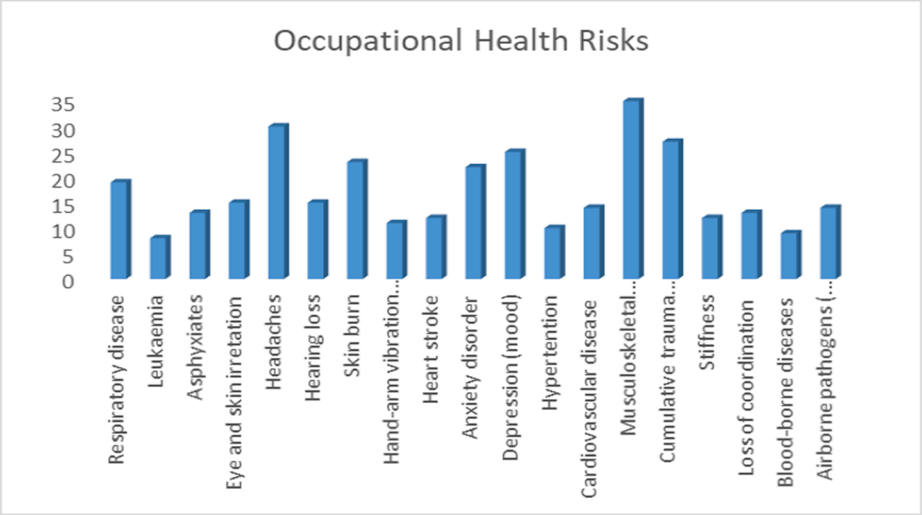

Fig. 3. Occupational health risks in the oil and gas industry.

found in the oil and gas industry. The hazards arise from inadequate food safety controls on offshore facilities, parasites, bacteria, and viruses.

6. Conclusion

The description of the various health hazards and their origins in the oil and gas industry and the risk associated with workers' health, taking into account this research aims, concludes that there are different occupational hazards in oil and gas's operating environment. Chemical, physical, psychosocial, ergonomic, and biological hazards are among these. From the research results, workers in the industry are exposed to various hazards, resulting in different health challenges. It is noted that most of the hazards presented in the industry have short-term health effects on workers, such as Headache, Airborne pathogens (common cold), Eye irritation, skin irritation, and skin burn. In contrast, others have long-term effects on workers' health, such as Leukemia, respiratory disorder, hearing loss, hand-arm vibration syndrome, hypertension, etc. Finally, the workers' health effects on the hazards exposed to, depending on the level, intensity of the exposure, the duration of exposure, and the organ exposed to the particular hazards will determine the level of damage or health challenges the worker will develop.

6.1. Recommendations

This study suggests the following: Adequate supervision should be imposed on the workers in their workplace, proper hazards assessment should be conducted in the industry, and compulsory medical testing should be carried out on workers always to know their health status.

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