ORIGINAL ARTICLE

Risk of Major Cardiovascular Events in Offshore Oil and Gas Industry Workers in Qatar

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ABSTRACT

Introduction: Oil and gas workers are exposed to various hazards in the workplace, which increases their risk factors and risk of major adverse cardiovascular events (MACE). There have been limited studies on the risk of MACE in workers within the oil and gas industry. **Methods:** We utilized a cross-sectional approach to analyze data spanning a decade for offshore and onshore workers of an oil and gas corporation in Qatar. By utilizing the Framingham Risk Score (FRS), we evaluated the risk of MACE within both groups. Data was retrieved from the corporation's electronic medical record. The corporation had 736 offshore workers and 1,041 onshore workers. A sample calculation determined that 48 data samples were required for the offshore workers, which were then rounded up to 50. Similarly, 50 data samples were obtained from the onshore workers for comparison. The samples were selected using a computer-generated random sampling method. Two sets of data, namely the first profile (2009) and the second profile (2019), were collected in each sample. The available data were used to compute the risk of MACE. **Results:** Over a ten-year period, both offshore and onshore workers experienced increased risks of MACE. For offshore workers, the risk escalated from 9.2(8.0)% to 20.4(15.2)%, whereas for onshore workers, the risk increased from 10.0(7.6)% to 17.0(11.0)%. The risk of MACE was found to be significantly greater among offshore workers compared to onshore workers (p=0.011). **Conclusion:** The deterioration in the risk of MACE was more pronounced among offshore workers in comparison to onshore workers.
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INTRODUCTION

Workplaces have been linked to the development and aggravation of cardiovascular diseases and risk factors through the influence of different types of hazards. These hazards can have direct or indirect effects on the occurrence and progression of cardiovascular diseases and risk factors. Examples of such hazards include physical factors (such as excessive heat, noise, and vibration), chemical substances (like carbon disulfide, carbon monoxide, and solvents), as well as biological and psychosocial factors such as work-related stress, strain, and shift work (1,2).

Among the working population, cardiovascular disease ranked as the second highest cause of mortality, accounting for 23% of all deaths (3). Both office and field workers are susceptible to cardiovascular risk factors. A study reported that 78.6% of office workers in India had two or more such risk factors (4). Similarly, a survey of oil and gas industry revealed that overweight, hypertension, dyslipidemia and diabetes were found in 62.4%, 35.5%, 24.3%, and 3% of the workers, respectively (5).

Offshore is a common type of work in the oil and gas industry. Offshore workers are typically engaged in activities related to the drilling, production, and transportation of oil and gas at sea. Such work is highly demanding, requiring employees to endure prolonged stays on mid-ocean platforms, work longer and varied shifts, contend with extreme weather conditions, and handle heavy and hazardous workloads. Additionally, offshore workers are exposed to numerous chemical, biological, and ergonomic hazards that pose risks to both their safety and health, including the development of cardiovascular disease and its associated complications. Studies indicated that offshore workers are at a 40% higher risk of developing cardiovascular disease and related risk factors than their onshore counterparts (6,7,8).

Individuals who have cardiovascular diseases or risk factors are at risk of experiencing major adverse cardiovascular events (MACE) such as heart failure, stroke, myocardial infarction, and even death during their lifetime. While MACE can have devastating consequences, their occurrence can be predicted through the use of risk calculation tools such as Framingham Risk Score, SCORE, QRISK (9). However, there are few studies that have investigated the risk of MACE in offshore workers, especially in oil and gas industry.

MATERIALS AND METHODS

Study Design and Aim

We conducted a cross-sectional study using ten years' worth of data of offshore workers of an international oil and gas corporation based in Qatar. We also collected data of onshore workers in the same corporation for comparison purposes. The data was used to compare the cardiovascular risk factors and MACE risk between the two groups. To predict the risk of MACE, we utilized the Framingham Risk Score (FRS).

Population and Sample

We obtained data for both groups from the electronic medical records of the corporation. Offshore workers were defined as individuals who worked on sea platforms on a permanent basis and followed a 7/7 work cycle (seven full working days followed by seven rest days). On the other hand, onshore workers were those who worked permanently on land.

The corporation employed a total of 736 offshore workers and 1,041 onshore workers. We determined the sample size using an unpaired group numerical analysis formula that considered the study type, error, standard deviation, and expected effect size. Based on this calculation, we required 48 data samples for the offshore group, which was then rounded up to 50. For comparison purposes, we also took 50 data samples from the onshore workers. Computer-generated random sampling was used to select the samples.

To select the data samples for both groups, we used the following inclusion criteria: individuals had electronic medical records, had relevant health data that could be compared over a ten-year period, and did not have a pre-existing cardiovascular disease according to their medical records.

Data Processing

We collected two sets of data, 10 years apart, for each sample. The first set of data was collected in 2009 (first profile), and the second set was collected in 2019 (second profile). We extracted age, gender, height, weight, blood pressure, sugar levels, cholesterol levels, smoking history, hypertension treatment, and diabetes status from each data sample in each set. Using the available data, we used FRS to calculate the risk of MACE. The risk of MACE was categorized as low (FRS<10%), moderate (FRS 10-20%), and high (FRS>20%) based on the FRS calculation. We compared the results of the calculations to identify any differences.

Statistical Analysis

We utilized the Statistical Product and Service Solution (SPSS) 20 statistical program to analyze the data from the samples.

Ethical Approval

This study was approved by Research Ethics Committee, Faculty of Public Health, Universitas Indonesia No.712/UN2.F10/PPM.00.02/2019

RESULTS

Table I presents the sample data of offshore and onshore workers at their first and second profiles. The average age of offshore workers in the first profile was 40.9 (6.9) years, and it increased to 50.9 (6.9) years in the second profile. In the second profile, compared to the first profile, there were significant increases in the following variables: systolic blood pressure (124.8 (11.0) mmHg to 130.4 (13.7) mmHg), fasting blood sugar (5.3 (0.7) mmol/l to 6.0 (1.7) mmol/l), LDL (2.9 (0.7) mmol/l to 3.1 (0.8) mmol/l), triglycerides (1.7 (0.9) mmol/l to 2.0 (1.1) mmol/l), and total cholesterol (223.4 (46.6) mg/dl to 243 (48.3) mg/dl). The number of offshore workers taking anti-hypertensive medication also increased from 8 to 14 workers, and the number of offshore workers diagnosed with diabetes increased from 4 to 11 workers. Using the FRS calculation, offshore workers had an elevated risk of MACE, increasing from 9.2 (8.0)% at the first profile to 20.4 (15.2)% at the second profile.

At the initial profile, the onshore workers had a mean age of 41.7(7.1) years, which increased to 51.7(7.1) years at the second profile. In contrast to the first profile, there were only two variables that showed significant increases in the second profile: HDL (40.1(13.7) to 42.9(10.6) mg/dl) and weight (81.0(13.2) to 83.0(12.0) kg). According to the FRS calculation, the risk of MACE for the onshore workers increased from 10.0(7.6)% at the initial profile to 17.0(11.0)% at the second profile.

Table II presents a comparison of the risk of MACE between offshore and onshore workers at the first and second profiles. At the first profile, both groups were categorized as low risk for MACE with an FRS score of less than 10%. The mean FRS score for offshore workers was 9.2(8.0)%, which did not differ significantly from onshore workers' FRS score of 10.0(7.6)% (p=0.175). However, at the second profile, the FRS score for offshore workers increased significantly to 20.4(15.2)% and was classified as high risk for MACE (FRS > 20%), while the FRS score for onshore workers was 17.0(11.0)% and was classified as moderate risk (FRS 10-20%).

Table I: Health Profile of Offshore and Onshore Workers

Groups	Offshore (n=50)			Onshore (n=50)		
Profiles	**First**	**Second**		**First**	**Second**	
Variables	**Mean (SD)**	**Mean (SD)**	**p-value**	**Mean (SD)**	**Mean (SD)**	**p-value**
Age (years)	40.9 (6.9)	50.9 (6.9)	0.000	41.7 (7.1)	51.7 (7.1)	0.000
Systolic blood pressure (mmHg)	124.8 (11.0)	130.4 (13.7)	0.001	130.0 (14.4)	132.4 (10.0)	0.505
Diastolic blood pressure (mmHg)	77.7 (10.6)	78.9 (11.5)	0.199	81.1 (7.0)	81.0 (9.3)	0.478
Fasting blood sugar (mmol/l)	5.3 (0.7)	6.0 (1.7)	0.001	5.9 (0.9)	5.9 (0.7)	0.496
LDL (mmol/l)	2.9 (0.7)	3.1 (0.8)	0.001	2.9 (0.6)	3.1 (0.7)	0.037
HDL (mg/dl)	40.1 (11.2)	41.3 (10.5)	0.491	40.1 (13.7)	42.9 (10.6)	0.007
Triglyceride (mmol/l)	1.7 (0.9)	2.0 (1.1)	0.001	1.3 (0.4)	1.4 (0.7)	0.189
Total cholesterol (mg/dl)	223.4 (46.6)	243 (48.3)	0.001	204.2 (31.5)	200.6 (42.9)	0.442
Height (cm)	170.0 (6.8)	170 (6.8)	0.500	170.0 (5.6)	170.0 (5.6)	0.500
Weight (kg)	82.0 (12.6)	84.1 (11.0)	0.001	81.0 (13.2)	83.0 (12.0)	0.015
Variables	**Number**		**p-value**	**Number**		**p-value**
Smoking						
Yes	5	8	0.125	6	6	0.500
No	45	42		44	44	
Hypertension medication						
Yes	8	14	0.008	13	16	0.187
No	42	36		37	34	
Diabetes						
Yes	4	11	0.008	9	11	0.250
No	46	39		41	39	
Risk of major cardiovascular events	**Mean (SD)**		**p-value**	**Mean (SD)**		**p-value**
Framingham Risk Score	9.2 (8.0)	20.4 (15.2)	0.000	10.0 (7.6)	17.0 (11.0)	0.000

Table II. Risk of MACE of the Offshore and Onshore Workers

Framingham Risk Score	Mean (SD)	p-value
First profile		0.175
FRS Offshore (%)	9.2 (8.0)	
FRS Onshore (%)	10.7 (7.6)	
Second profile		0.233
FRS Offshore (%)	20.4 (15.2)	
FRS Onshore (%)	17.0 (11.0)	
Change between first and second profiles		0.011
Change of FRS Offshore	11.2	
Change of FRS Onshore	7.0	

When comparing the first and second profiles, it was found that both groups of workers experienced increased risks of MACE (Fig. 1). The offshore workers showed a significant increase in risk from 9.2(8.0)% to 20.4(15.2)% (p=0.01), indicating a 121.2% rise, which shifted them from low to high risk (FRS >20%). In contrast, the onshore workers experienced a 70% increase in risk, from 10.0(7.6)% to 17.0(11.0)% (p=0.01). However, the category of risk remained unchanged and was still in the moderate risk category (FRS 10-20%). Furthermore, the offshore workers showed a greater increase in the risk of MACE over the 10-year period compared to the onshore workers (p=0.011).

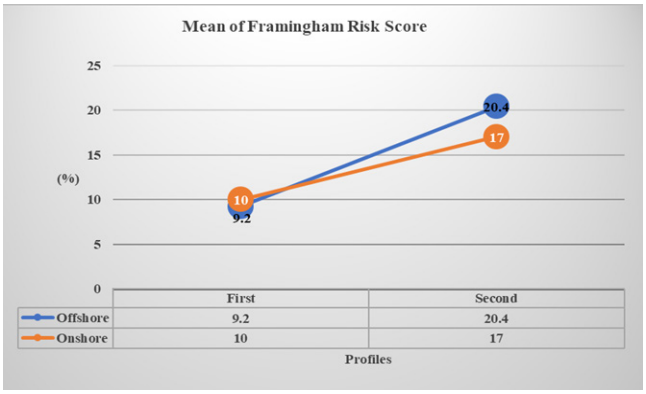

Figure 1: The Changes in the Risks of MACE among Offshore and Onshore Workers

DISCUSSION

The prevalence of cardiovascular risk factors in Middle Eastern countries is significant, with hypertension, diabetes mellitus, dyslipidemia, and smoking being particularly prevalent. In Saudi Arabia, Bahrain, Oman, Qatar, United Arab Emirates, and Kuwait, the prevalence of hypertension ranges from 26.0% to 50.7%, while the prevalence of diabetes mellitus ranges from 6.0% to 23.7%, dyslipidemia from 17.0% to 54.9%, and smoking from 13.4% to 37.4% (10). In Qatar's general population, hypertension and diabetes mellitus account

for 32.9% and 10.4%, respectively (11).

At the first profile, the offshore and onshore workers had a similar risk of MACE, with both groups having an FRS <10% and being classified as low risk. This risk level is consistent with the risk of MACE observed in the general population of some Middle-East countries. In Qatar, for example, the average MACE was 9.5% (12). Another study reported that 81.6% of the country's population had a low risk of MACE based on FRS calculation, while 3.8% had high or very high risk (13).

Following a ten-year follow-up, the offshore and onshore groups experienced a significant increase in the risk of MACE. While multiple factors could have contributed to this increase, the most significant one was aging. The age component is a crucial contributor in the FRS calculation. If other factors are kept constant and only consider age, the FRS for individuals aged 42 years is 4.8%. Over a ten-year period, this score will rise to 8.8%, which is an 84.2% increase. In an Iranian study, the average FRS in the population aged 25-34 years was 5.5%, but it jumped to 31.4% when people reached 55-64 years old (14). There are several hypotheses regarding the mechanism by which aging increases the risk of MACE. One of them is that as age increases, tissue degeneration occurs, which raises the risk of insulin resistance and leads to a range of metabolic disorders, including high blood pressure, metabolic syndrome, and dyslipidemia (15). Our multivariable analysis showed that age was the most significant variable affecting FRS in both offshore and onshore workers in both the first and second profiles.

Despite both groups experiencing an increased risk of MACE over the 10-year period, the offshore workers had a greater increase than the onshore workers (11.2% vs 7%). On average, the FRS increased by 1.1% per year for offshore workers and 0.7% per year for onshore workers. Although several factors may have contributed to the increased risk, longer and more varied shift work experienced by offshore workers has been associated with a higher risk of MACE. Studies have found that shift work disrupts circadian rhythms, increases stress-related hormones, causes abnormal inflammatory responses, and has a direct effect on increasing blood pressure. Shift work also increases the progression of cardiovascular risk factors such as hypertension, diabetes, smoking, obesity, alcohol consumption, and lack of physical activity, which eventually increase the risk of MACE (16,17). Numerous studies have reported a strong association between shift work and cardiovascular diseases and risk factors. One systematic review found that shift workers had a higher risk of coronary heart diseases than non-shift workers, with every year of shift work associated with a 0.9% increase in the prevalence of coronary heart disease (18). Another systematic review reported that shift work was associated with the occurrence of myocardial infarction (RR 1.23, 95% CI: 1.15-1.31), coronary events (RR 1.24, 95% CI: 1.10-1,39) and ischemic stroke (RR 1.05; 95% CI: 1.01-1.09). The population's attributable risk for myocardial infarction, coronary events and ischemic stroke in the shift workers were 7.0%, 7.3% and 1.6%, respectively (19).

At the first profile, there was no discernible difference in the risk of MACE between the offshore and onshore workers. However, over a period of 10 years, the offshore workers experienced a higher increase in the risk of MACE compared to the onshore workers (11.2% vs. 7.0%). This disparity can be attributed to the dose-response relationship, whereby the offshore workers were exposed to progressively more adverse working conditions than their onshore counterparts, resulting in a more rapid increase of their risk factors. Consequently, it is plausible that the risk difference between the offshore and onshore workers would continue to widen over time if the study period were extended. In line with this, a meta-analysis found that the risk of MACE becomes significant after 5 years of shift work, and increases by 7.1% for every additional 5 years of shift work (20).

The limitation for this study is the sample size used in this study was only intended to detect a 10% increase in FRS. Furthermore, factors that contributed to cardiovascular risk factors, such as dietary pattern, level of activities and exercise, number of work shifts per month and stress level, were not quantified in this study.

CONCLUSION

Over a span of ten years, the risk of MACE considerably rose in both offshore and onshore workers, resulting in a shift in risk category from low to moderate for the onshore group and from low to high for the offshore group. The offshore workers experienced a greater deterioration of cardiovascular risk factors compared to onshore workers, placing them at a higher risk of MACE. These results suggest the necessity for a program aimed at reducing risk factors and the likelihood of MACE, especially for offshore workers.

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