A comparison of coronary heart disease risk factor prevalence among offshore and onshore workers in the petroleum industry in Nigeria

by

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Declaration:

I, Dr. Isang Akpan Iwot of the Department of Family Medicine and Primary Care of the University of Stellenbosh, hereby declare that this research work on the comparison of cardiovascular risk factor prevalence among offshore and onshore workers in the petroleum industry in Nigeria, was carried out by me under the supervision of Professor Bob Mash. I also declare that this work has not been submitted in part or in full for any other examination.

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Abstract

Background: Coronary heart disease is a global public health problem. Formerly considered rare in sub-Saharan Africa, evidence has shown that urbanization and the adoption of more affluent and sedentary lifestyle in subpopulations of this region, may result in increased prevalence. One such subpopulation is workers in the Nigerian petroleum industry and this study examines their risk factors for coronary heart disease. In addition the study compares the risk profile of onshore and offshore workers.

Method: This is a descriptive cross sectional study undertaken to determine the level of risk factors for the development of cardiovascular disease in two groups of male workers of the petroleum industry in Nigeria; the onshore and the offshore workers. Four hundred workers were randomnly selected and invited to participate, with a desired sample size of 234. The data was collected by using an electronic questionnaire to explore life style factors like exercise, diet, and smoking that predispose to this disease. Anthropometric indices included body mass index, waist circumference and waist to hip ratio. Biochemical tests included lipid profile and fasting blood glucose. Systolic and diastolic blood pressure was also recorded. The prevalence of known hypertension and diabetes as well as the metabolic syndrome were determined. The questionnaire data was analysed and compared with the chi-square test using the software, Epi-info 2008 Windows Version 3.5.1 and the means of the continuous variables were determined and compared using analysis of variance (ANOVA).

Results: 121 onshore and 110 offshore workers participated. Overall the cardiovascular risk profile of onshore versus offshore workers in the oil industry was worse. Onshore workers had increased waist circumference,; though there was no significant difference in the Waist-Hip Ratio, increased rates of metabolic syndrome, diabetes and hypertension and were less physically active.

Dietary differences were less marked, but more beef and chicken were consumed by onshore while more fish was consumed by offshore workers. Conversely the offshore workers had a higher BMI and lower levels of protective HDL. Overall, in this population, the BMI and the umber of diabetics were higher and the HDL lower than the country figures.

Conclusion

The obesity profile of the two groups was comparable to that of the Western nations and could become worse. This also reflects the fact that within Nigeria there are sub-populations with cardio-metabolic profiles that depart significantly from the national average. This is most probably due to dietary factors and poor exercise habits and calls for intervention through health promotional activities

1. Introduction and Background

1.1 Background

Coronary heart disease is a well established health problem globally[1]. It has been extensively researched and the risk factors are well described[2]. In addressing this issue, it is proper to focus on populations, as interventions applied to populations can reinforce individual motivation to change[3].

The setting for this study is Southern Nigeria which hosts the petroleum industry; the source of over 90% of Nigeria income. This is a significant workforce with special characteristics because the global nature of its operation exposes workers to a lifestyle pattern similar to more affluent Western countries.

Usually considered a disease of affluence, there is a low index of suspicion for coronary heart disease in general medical practice in this community, a typical sub-Saharan African community. Although it has perhaps been rightly believed that the prevalence is very low; this may not be so in this sub population of workers with a higher income and access to a western type lifestyle.

This lifestyle includes; atherogenic diets, with an excessive calorie intake against the background of a sedentary life style and smoking. Lifestyle change can modify the course of genetically determined cardiovascular diseases[4].

In the traditional setting of Sub-Saharan Africa, cardiovascular risk factors are not considered as significant health problems. Farming and managing livestock, for example, involves hard physical labour as well as walking long distances. Diets are typically low in red meat, processed and refined foods. Most people eat whole foods and vegetables and far less meat or fat than in more developed countries.

With urbanization and globalization, descendants of more and more families have left the traditional subsistent occupations, which are associated with manual labour, to join the ranks of sedentary office workers; with income that provide more access to western type diet, such as oil and processed foods high in fats and sugar, as well as technology that replaces physical exertion at work and at leisure.

This has to a large extent produced a sub-population of overweight to obese individuals with biochemical indices that reflect the West rather than their rural relatives. To worsen this, exercise as a leisure activity is not conventionally African; exercising is considered as a childhood pastime, unlike in the European or American culture where there is an established expectation of exercise. In the Nigerian context house-hold chores are performed by house-helps. House-help is relatively cheap and affordable, even by the working class.

This study focused on risk factors for CHD in a Nigerian sub-population, within the petroleum industry, where it was anticipated that a more westernized lifestyle might be emerging. If confirmed this would help to alert authorities to the likely growth of chronic diseases of lifestyle amongst populations in sub-Saharan countries.

Offshore and onshore workers are in an income group that is far above senior officials of the civil service and most companies. Both groups are therefore similar in terms of what their income can provide. The reason for comparing them is to determine whether there is any differences in lifestyle, physical and biochemical characteristics, that increase their risk of coronary heart disease, given the different nature and environment of work.

Whereas there are shared risk characteristics between the groups, it is possible to develop location specific health promotion interventions to address those risks that can be attributed to the uniqueness of each work place.

1.2 Literature review

Coronary heart disease

Coronary heart disease (CHD) has been reported as absent in rural Sub-Saharan Africa and very uncommon in urban centres, despite a higher intake of fat and levels of serum cholesterol. [5,6]. However a more recent study suggests a steady increase of CHD in sub-Saharan Africa due to urbanization, life style changes, and acquisition of technology.[7]

Risk factors for CHD

The major risk factors for CHD, from the WHO report can be summarized as follows: [8]

1. High blood pressure: Suboptimal blood pressure is associated with 49% of CHD.
2. High cholesterol is associated with 56% of CHD.
3. Obesity, overweight and high body mass index (BMI) is associated with 21% of CHD.
4. Low fruit and vegetable intake is associated with 31% of CHD
5. Physical inactivity is associated with 22% of CHD.
6. Smoking is associated with 22% of CHD
7. Diabetes is associated with 20% CHD[9] .These risk factors are recognized by the WHO and their contributions to cardiovascular morbidity are possibly additive in their effect[10]. South Africa carried out a comparative risk assessment for the contribution made by different risk factors to deaths and found out that 8 out of the first 10 ranked positions were risk factors for CHD[11]; as a sub-Saharan African study, this is a significant development.

A study carried out in Northern Nigeria on Fulani pastoralists showed that nearly 50% of energy from their food was provided by saturated fat, however the total energy content was low and came from dairy products, fat and oil. Their pastoral lifestyle provides adequate exercise, so the Fulani have a normal BMI and lipid profile.[12] Exercise, indirectly imposed on the Fulani by their nature of work, as well as their low overall energy intake more than compensates for the atherogenic diet of saturated fat. In a follow up study the rural Fulani were compared to an urbanized population in Jos, Northern Nigeria and a significantly higher prevalence of cardiovascular risk factors, such as mean total cholesterol, lower HDL and higher triglyceride were demonstrated in the latter group.[13]

The metabolic syndrome

The metabolic syndrome (MS) predisposes to CHD. The Oxford Concise Medical Dictionary defines MS as "a common combination of insulin resistance with type 2 diabetes, obesity with fat distribution mainly around the waist, high blood pressure, dyslipidaemia, and early atherosclerosis".[14] The collection of these multiple risk factors translates to at least a 20% ten year risk of CHD.[15] This syndrome as a clinical entity presents all the key biochemical indices and anthropomorphic features that on their own predispose to cardiovascular disease. The threshold levels for anthropomorphic measurements of abdominal obesity and biochemical indicators vary with studies and published definitions. It is therefore necessary to define the thresholds that will be used in

this study.

The cut off for the waist circumference, in the National Cholesterol Education Programme (NCEP) studies, applies mostly to Caucasians. In a study carried out on Asian subjects, the threshold level for the waist circumference was based on a BMI of 23 kg/m^2 ,while that for adult European Caucasians was based on 25 kg/m^2. The study concluded that Asians have relatively higher truncal abdominal fat mass compared to Caucasian and African populations, despite similar or lower average value for waist circumfrence.[16] Therefore, the cut off measurement for cardiovascular risk should be less in Asian populations. The study mentioned that this phenomena is also reported in non-Asian populations in Nigeria, Cameroon, Jamaica, St Luicia and Barbados.[17].Asian-Indian patterns of adipose tissue distribution have also been reported as identical to Afro-American men.[18] However, despite the findings above, current advice is that Sub-Saharan Africa should use European data until more specific data are available.[19]. The importance of this issue is further emphasized as the Waist to Hip Ratio (WHpR) has been reported to be a better predictor of cardiovascular risk than the BMI, waist circumference (WC) and waist to height ratio (WHtR) in Tehranian adult men.[20].

The box below summarises the definition of the metabolic syndrome by six organizations, one in Europe, three in the USA and two internationally.

Organization	**World Health Organization (WHO)** (1998) Requires impaired glucose tolerance, diabetes, or insulin resistance plus two or more other risk factors	**European Group for the Study of Insulin Resistance (EGIR)** (1999) Requires insulin resistancea plus two or more risk factors	**National Cholesterol Education Program-Adult Treatment Panel III** (2004) Requires three or more risk factors	**American Association of Clinical Endocrinologists (AACE) (**2003)	**International Diabetes Federation (IDF)** (2005) Requires central obesity plus two or more other risk factors	**American Heart Association together with the National heart, Lung and Blood Institute (AHA/NHLBI)** (2005)
BP (mmHg)	≥140/90	≥140/90	≥130/85	≥138/85	≥130/85	≥130/85
TGL	≥150 mg/dL	≥177 mg/dL	≥150 mg/dL	150 mg/dL (1.69 mmol/L)	≥150 mg/dL	Men >150mg/dl (1.7mmole/l)
HDL	Men <35 mg/dL; women <39 mg/dL	<40 mg/dL	Men <40 mg/dL; women <50 mg/dL	Men 40mg/dl (0.9 mmole/l) Women 50mg/dl (1.1mmole/l)	Men <40 mg/dL; women <50 mg/	Men 40mg/dl (0.9 mmole/l) Women 50mg/dl (1.1mmole/l)
FBG	N/A	>110 mg/dL	≥110 mg/dL	110 -126 mg/dL 2hr post priandial of ≥140mg/dl	>100 mg/dL	≥100 mg/dL
Central Obesity	men >0.9; women >0.85	Waist circumfere	Waist circumferen	BMI ≥25 kg/m^2	Waist circumference:	Waist circumference

		nce: men ≥37 in (94 cm); women ≥31.5 in (80 cm)	ce: men >40 in (102 cm); women >35 in (88 cm)		men ≥37 in (94 cm); women ≥31.5 in (80 cm)	Men ≥102cm/40in Women ≥88cm/35in
Micro-albuminuria	≥20 mcg/min or Alb/Cr ratio ≥30 mg/g	N/A	N/A	n/a	N/A	N/A

Though there are variations in the cut of levels applied to each measurable risk factor, all have reached the consensus about the cluster of inter-related risk factors that are due to abdominal obesity and insulin resistance and which promote the development of atherosclerotic cardiovascular disease[21].
The importance of this to this research is that the threshold used to define each risk factor must be properly referenced.

Lipids
The capacity for atheroma formation is highly correlated with the level of circulating lipids. As a biochemical indicator/risk factor, it was concluded that high serum triglyceride is an important independent predictor of CHD and stroke in the Asian Pacific region.[22] High density lipoprotein (HDL) cholesterol, which is in an inverse relationship to the risk of coronary heart disease is protective and low density lipoprotein (LDL) cholesterol is associated with a higher risk [23].
In a study of serum lipids in Nigerian higher economic status civil servants, aged 25–54 years, a high LDL cholesterol was associated with higher BMI[24].The Nigerian oil workers have a significantly higher income than the civil servants and therefore this study expected a similar finding.

Exercise
While lack of exercise and associated weight gain are risk factors for CHD, aerobic exercise and weight loss improve carbohydrate metabolism and lower blood pressure.[25]. The study in Northern Nigeria on Fulani pastoralists, reviewed earlier, supports this.
A modest amount of moderate intensity exercise, in the absence of dietary changes, greatly improves the MS and therefore it has been recommended that adults get 30 minutes of moderate intensity exercise every day. This study presents data from Studies of a Targeted Risk Reduction Intervention through Defined Exercise (STRRIDE). The study also concluded "*It is possible that higher amount of exercise at a more vigorous intensity were not significantly better than inactive controls*" [26], implying that there is a threshold above which exercise does not effectively add value to CHD risk mitigation.

Dietary factors
Fung et al aptly described two eating patterns[27]:

> *"The first was characterized by higher intakes of fruit, vegetables, whole grains, legumes, poultry and fish (labeled 'prudent'). The second was characterized by higher intakes of red and processed meats, refined grains, chips, desserts and*

sweets (labeled 'Western'). A diet high in fruit, vegetables, whole grains, legumes, poultry and fish reduces the risk of coronary heart disease by 24%. A diet high in red and processed meats, refined grains, chips, desserts and sweets increases the risk of coronary heart disease by 46%."

In the same study, it was also determined that a higher glycemic load was strongly associated with an increased risk of coronary heart disease.

Offshore workers in the Norwegian part of the North Sea have been shown to choose a diet that may contribute to the development of CHD and thereby increasing the mortality and morbidity in the oil industry.[28] Food served on offshore oil installations in Nigeria is a combination of the traditional African, high carbohydrate and fibre diet, alongside a more Westernised menu. The traditional diet is not as adverse to the cardiovascular system and this partly accounts for the low incidence in the rural population.

The favourite oil used in cooking Nigerian meals is palm oil. This is considered not as healthy as olive, sunflower, canola or soya oil because the ratio of saturated fat to unsaturated fat is 1:1. [29,31] However the consumption of unprocessed and uncooked (unoxidised) palm oil is associated with a drop in total cholesterol.[30, 31] The consumption of moderate amounts of palm oil and reduction in the level of oxidation may reduce its health risk.[31] . However increases in imports of cheap vegetable oils is thought to be one factor in increased obesity.[32]

Smoking,

Smokers' risk of developing CHD is 2–3 times that of non-smokers.[33] Cigarette smoking doubles the risk of sudden cardiac death in patients with CHD.[33] People who smoke cigars or pipes have a increased risk of death from CHD (and possibly stroke), but their risk is lower than cigarette smokers.[34] Exposure to other people's smoke also increases the risk of heart disease even for non-smokers.[35] The increasing prevalence of CHD in the developing world has been described as "exporting failure".[36] Smoking in developing countries is of growing concern as consumption in the developed world has reduced, but manufacturers' cigarette production and profits have increased through targeting new and less regulated markets in developing countries.[37]

Smoking related differences in risk markers for coronary disease is evident in high total cholesterol, triglycerides, fibrinogen, lower HDL and higher blood pressure.[33]

High blood pressure:

Hypertension is a common and major contributor to CHD morbidity and mortality. The Framingham program has studied this condition exhaustively. The risk of every manifestation of CHD including angina, coronary insufficiency, myocardial infarction and sudden death was related not solely to "hypertension" but was proportional to the blood pressure even at non-hypertensive pressures. [37] Risk of coronary disease, the most common and most lethal sequel to hypertension, increased stepwise with the extent of risk factor clustering. Among persons with hypertension, about 40% of coronary events in men and 68% in women are attributable to the presence of two or more additional risk factors. Only 14% of coronary events in hypertensive men and 5% of those in hypertensive women occurred in the absence of additional risk factors.[38.] Those other risk

factors that tend to accompany hypertension include glucose intolerance, obesity, left ventricular hypertrophy, and dislipidemia (elevated total, LDL, and very low density LDL cholesterol levels, raised triglyceride, and reduced HDL cholesterol levels).

Diabetes Mellitus
Diabetes Mellitus, though defined by higher than normal values for blood glucose is associated with cardiovascular risk factors through the metabolic derangement that is associated with it. These risk factors are, increase in LDL, lower HDL, increased triglyceride and raised blood pressure [39]. The prevalence is rising globally; estimated as 2.3% for all age groups in year 2000 and projected to 4.4% in year 2030.[40] Estimates for Sub-Saharan Africa during the 19th World Diabetic Congress in South Africa , is for an 80% increase by 2025 as opposed to the global increase of 50%. This is partly due to the diabetogenic effect of highly active anti-retroviral therapy (HAART). [41]. Given the multiple CHD risk factors associated with diabetes, this will result in more cases of CHD. Its association with many risk factors and relationship to the metabolic syndrome, makes it an important disease to consider in cardiovascular risk assessment.

Genetic cardiovascular risk factors
The gene is a strong predisposing factor for the manifestation of many chronic disesases following impact by environmental factors. However, it is the environmental influences on the genetic factors that determine disease development[42] For instance, the E4 allele on the Apolipoprotein E gene increases the risk of CHD by 40% and the development of late onset Alzheimer disease in 50% of affected individuals[43] Approximately ten major types of dyslipidaemia with genetic links are identified. Familial Dyslipidaemia (FH) with defect on gene LDLR is the commonest (1 in 500) . Identification of these genes in conjunction with environmental factors which include life style constitutes an important approach to family oriented preventive medicine[44]. Furthermore, in a study carried out on African Americans, there is the possibility that Apolipoprotein E2 carriers by virtue of the more favourable lipid profile that it confers, may account for the relative protective effect on CHD compared to Caucasians[45]

Though the genetic factors are not assessed in this study, it is worth considering in a future research in this population for a more complete application of preventive strategies, and to modulate therapeutic options.

Other factors
Other CHD risk factors like alcohol[46], homocysteine, C-reactive protein [47], shift work [48] [49, 50]; stress and physical workload [50,451, 52] were not considered in this study.

2.0 Aim and objectives

2.1 Aim of the study
The aim of this study is to compare the prevalence of risk factors for coronary heart disease (CHD) in offshore workers of the Nigerian petroleum industry with their onshore counterparts.

2.2 Objectives of the study

The objectives of this study are derived from the hypothesis that this group of workers is more exposed to dietary factors that predispose to CHD due to easy access to Western type diet and their relatively high income that enables a life style of high calorie and fat intake. Another factor is the lack of opportunity and motivation for exercise. Anecdotal observation suggested that there were many overweight, diabetic and hypertensive persons in this population. The specific objectives of the study were:

- To determine the prevalence of CHD risk factors in the study population.
- To compare CHD risk factors in the selected offshore and onshore workers in the same industry.
- To make recommendations based on this study so that health resources could be effectively targeted as well as motivate interest for more research in this area.

3. Methods

3.1 Study Design

A descriptive cross sectional survey.

3.2 Setting and study population

The study population, of 1,170 male employees in the oil fields of Southern Nigeria, was split between 520 working on 11 offshore oil platforms in the Atlantic Ocean and 650 working in 2 onshore office facilities on the land. The study population was aged between 25 and 60 years and most had worked for at least 5 years in the industry.

3.3 Assignment

Inclusion criteria

Male employees of the petroleum industry working onshore or offshore on oil production platforms. Employees who were known with hypertension and diabetes were included.

Exclusion criteria

Offshore workers on drilling rigs, service barges or any other vessel offshore were excluded. Female workers were not included as their population offshore is not significant. Expatriate employees were also excluded.

Sample size calculation

This sample size was based on the assumption that 25% of the population would have cardiovascular risk factors and a standard error of 4. The estimated proportion of the population with cardiovascular risk factors was based on reports in similar populations in neighboring Cameroon [53, 54]. With an estimated spread of 8% from the mean and at 95% confidence interval, 5% from either side of the mean, a sample size of 117 was required for each group (offshore vs. onshore employees) and a total sample size of 234.

Sampling

The participants were selected by simple random sampling using the list of employees with their employee numbers in the sampling frame. The sampling was done using an

electronic table of random numbers. Two hundred names were drawn from each group and invitations to participate were sent by email. The participant's information leaflet, consent form and questionnaire were also attached.

3.4 Assessment

If the participant consented to the study they completed the on-line questionnaire and thereafter reported to the clinic to submit samples for the laboratory tests and to have the anthropometric data collected. Data was collected by clinic staff (doctors or nurses) and blood samples analyzed by laboratory staff at the Mobil House clinic Lagos, Mobil Clinic Apapa, and the Management Housing Estate clinic, Eket. The researcher supervised the collection and collated the data from the various locations. All equipment was calibrated and standard operating procedures, for use by different staff members, were defined for measurement of blood pressure and waist circumference. The following risk factors were measured:

1. Blood pressure
2. Blood glucose (fasting)
3. Total cholesterol
4. Triglycerides
5. High Density Lipoprotein
6. Weight
7. Height
8. Waist and hip circumference
9. Lifestyle questionnaire
    - Exercise
    - Diet
    - Smoking

Low Density Lipoprotein (LDL) was not measured in this study. The laboratory calculates the value from the known total Cholesterol, Triglyceride and HDL levels. The researcher based the risk assessment on the total cholesterol, triglyceride and the inverse effect of HDL in artheroma formation. The mean LDL for the study population was calculated from the means of the three fractions.

Although the risk factors are all recognized internationally, their relevance to this population has to be interpreted with some caution. Research information on these risk factors in sub-Saharan Africa is scanty and researchers have to rely on European or American standards. For example, the appropriate risk level for waist circumference is not defined in our African context.

Blood pressure measurement

This was carried out according to The European Hypertension Society, and the American Heart Association recommendation on the measurement of Blood Pressure which the Joint Hypertension Working Group fully endorses and adapted for the South African Hypertension Guideline[55].

Biochemical measurements
Fasting venous blood samples were taken for the determination of glucose level and lipid profile.

Anthropometric data
Weight was measured to the nearest 0.1 kg. Height was measured to the nearest 0.5 cm using a wall-mounted stadiometer. Body mass index (BMI) was calculated as weight (in kg) divided by the square of the height (in metres). The waist circumference was measured by placing a tape measure around the bare abdomen just above the hip bone, at the level of the navel. The tape was snug, but did not compress the skin, was parallel to the floor and measurement was made when the subject was relaxed and had exhaled. The hip measurement was made at the widest point of the hip where the buttock protrudes most. In a study carried out specifically on oil workers in the Norwegian sector of the North Sea, a combination of BMI and WHR were considered strong enough predictors to be useful in routine screening for CHD risk at worksites. [56]

Standards for anthropometric data collection
The method for the measurements was well defined and standardized. This included the equipment calibration verification, measurement procedures for height, weight, waist and hip circumference. Definition of the anatomical landmarks used for the measurement of the waist circumference was according to the United States Department of Health and Human Services:
"To measure your waist circumference, place a tape measure around your bare abdomen just above your hip bone. Be sure that the tape is snug, but does not compress your skin, and is parallel to the floor. Relax, exhale, and measure your waist."[57] The hip measurement is at the widest point of the hip where the buttock protrudes most.

Definition of terms
The following definitions are used as cut off values for the purpose of this study:

World Health Organization (WHO) 1999 definition of High Blood Pressure

- SBP ≥ 140 mmHg and/or DBF ≥ 90 mmHg.

International Diabetic Federation (IDF) 2006 definition of risk thresholds,

- Waist circumference of > 94 cm (men)
- Fasting triglycerides > 1.70 mmol/l (150mg/dl) or triglyceride lowering drugs.
- Fasting plasma glucose ≥ 5.6 mmol/l (100mg/dl) or anti-diabetic treatment.
- Fasting total cholesterol ≥ 5.2 mmol/l (40mg/dl) or previous treatment
- HDL <1.03 in males

Metabolic Syndrome using the IDF criteria was defined as a waist circumference of >94cm and two of the other criteria.

The definition of diabetes mellitus is based on the report of a WHO/IDF (2006) consultation : Fasting plasma glucose ≥ 7.0mmol/l (126mg/dl) or 2–hour post priandial plasma glucose ≥ 11.1mmol/l (200mg/dl)[58].

This study only took account of known diabetics that participated in the studies and hyperglycaemia based on the IDF level of ≥5.6mmol/l as defined by the IDF risk threshold for the metabolic syndrome. Those that had a level of ≥ 7.0mmol/l, were only assumed to be new diabetics as the 2hr post prandial test was not part of the study.

The Framingham risk score

The Framingham heart study has played an important role in identifying many major risk factors for cardiovascular disease, and has led to the publication of about 1,200 research articles in leading journals (American Heart Association).

This work addresses some of the very risk factors highlighted in the Framingham study namely; age, sex, high blood pressure, smoking, dyslipidemia, and diabetes,. The Framingham tool for the assessment of the risk profile was used. The particular electronic calculator used was accessed through: http://www.medcalc.com/heartrisk.html[59]

Questionnaire

A simple questionnaire was designed to address the basic elements of lifestyle (Appendix 2). It was reviewed by peers and validated before applying it to the research proper. The questionnaire was divided into sections that addressed exercise, diet and smoking habits. In assessing exercise, an estimate of the frequency and type/level of activity was made. For diet questions were structured to determine whether the preferred menu was atherogenic or so called Western (excessive red meat, fat and oil) or prudent (fish, chicken or white meat, fruits and vegetables).[27]

The term ration used in the questionnaire, is a popular local terminology referring to a meal serving. It is a rough guide to the quantity of food eaten by the resposndents . One ration is equivalent to two scoops of rice or grains, two rolls of cassava or yam flour or any equivalent normal serving in the restaurant.

Estimation of the proportion of tobacco smokers in the study population was determined. This estimate was based on the number of years that the participant had smoked, as well as the number of cigarettes per day. The questionnaire, that was designed to assess life-style, had to be adequately tailored to local circumstance and culture to ensure that it was a valid tool.

The word “mineral” was used to describe carbonated or soft drink in the questionnaire as it is in common usage in Nigeria. A combination of all types of meat in the option refers to a popular delicacy consisting of red meat, organ meat and skin or other offal, as a stew or sauce, and which is high in saturated fat content. The significance of the egg question is due to the oil used to fry it and not the cholesterol content of the eggs, as eggs are usually fried with processed oils. Alcohol questions were removed from the questionnaire design as the response was not going to be reliable. Alcohol and drugs are banned at the workplace and it is usually a sensitive question for workers.

Piloting
A pilot study was carried out using 20 workers haphazardly selected from each group and some aspects of the questionnaire and sample collection processes were modified as a result.

3.5 Analysis
The anthropometric, biochemical, blood pressure and demographic information were first entered against each participant on one excel spreadsheet each for onshore and offshore locations. The questionnaire responses were also captured on an excel spread sheet and the responses separated into onshore and offshore.
Chi-squared test, was used for the comparison of the categorical data from the questionnaire responses using Epi-info 2008 Windows Version 3.5.1.While analysis of variance (ANOVA) was use to compare the continuous variable data from anthropometric measure, biochemical test and blood pressure readings. The Mann-Whitney p value was used to detect significant differences in the ANOVA.

3.6 **Ethical considerations**
Ethical approval was obtained from the Committee for Human Research at Stellenbosch University and the Human Research Ethics Committee (HREC) of the global company, ExxonMobil. Permission to conduct the study was also obtained from Mobil Producing Nigeria.

4. Results

A total of 231 workers completed the questionnaire (110 from offshore and 121 from the onshore locations), while 203 also completed the further testing at the clinic (102 from offshore and 101 onshore). Table 1 shows the age and duration of employment in the two groups of male workers.

4.1 Analysis of the lifestyle questionnaire

Table 1 compares the age of participants and the duration of work at their location. There was no significant difference in age and duration of work at each location between the two groups. Seventy nine percent (79.x)% of offshore and 82.x% of onshore workers were below 45 years.

Table 1: Comparison of the age and duration of work

Variables	**Offshore N=110**	**Onshore N=121**	**p-value**
	n (%)	n (%)	
Age (years)			
25-34 years	39 (35.5)	35 (28.9)	0.753
35-44 years	40 (36.4)	47 (38.8)	
45-54 years	30 (27.3)	38 (31.4)	

> 54 years	1 (0.9)	1 (0.8)	
Duration of continuous work at location?			
5-9 years	42 (38.2)	48 (37.9)	0.239
10-14 years	41 (37.3)	36 (29.8)	
15-20 years	20 (18.2)	33 (27.3)	
> 20 years	7 (6.4)	4 (3.3)	

Table 2 demonstrates the frequency of exercise. There was no significant difference between the two locations in the frequency of exercise, but they differed in the type of exercise. Only 32 (30.0%) of offshore workers and 45 (37.2%) of onshore workers engaged in exercise for at least 3 days a week, which was the desired target.

Table 2: Comparison of subjects' frequency of exercise

Variables	**Offshore N= 110**	**Onshore N= 121**	**p-value**
	n (%)	n (%)	
Frequency of exercise			
> 3 days a week	15(13.6%)	22(18.2%)	0.348
3 days a week	18(16.4%)	23(19.0%)	
< 3 days a week	62(56.4%)	54(44.6%)	
None	15(13.6%)	22(18.2%)	

The distribution of the workers' most frequent day to day activity off- the- job and during working hours are summarized in Table 3. Thirty five percent (35.4%) of offshore employees indicated that they were involved in activities ranging from gardening to laundry, washing the car and other domestic chores as compared to 26.4% of their onshore counterpart. Activity during the eight hours working day showed that more offshore employees (71.8%) compared with their onshore counterparts (29.3%) were engaged in various levels of physical activities. Onshore workers were more likely to be sedentary and seated at a work station.

Table 3: Comparison of subjects Off-the-Job and On-the-Job activities

Variables	**Offshore N= 110**	**Onshore N=121**	**P-value**
	n(%)	n(%)	
Most frequent day to day activity; off-the-job			
Domestic chores (e.g. laundry, ironing, car wash)	16(14.5%)	28(23.1%)	<0.01
Physical activity in your environment (e.g.	23(20.9%)	4(3.3%)	

gardening)			
Driving a car	43(39.1%)	31(25.6%)	
Watching television	3(2.7%)	35(28.9%)	
No specific activity	25(22.7%)	23(19.0%)	
Most frequent work place activity in 8 hours working days			
Heavy duty	16(14.5)	0(0.0)	<0.01
Climbing	28(25.5)	4(3.3)	
Brisk walking	35(31.8)	29(24.0)	
Seated at work station	31(28.2)	88(72.9)	
Total	**110(100%)**	**121(100%)**	

Table 4 compares the two groups in terms of the snacks that they commonly took in between meals, drinks (not alcohol) and consumption of fruit. There was no significant difference between the two groups. Alcohol consumption was not asked as the response would not be reliable given the company's stringent alcohol and drug policy.

Table 4: Comparison of subjects' snack habits, drinks and fruit consumption

Variables	**Offshore N= 110**	**Onshore N=121**	**p-value**
	n(%)	n(%)	
Snacks between meals?			
Fruits/Vegetables	21(28.3%)	42(34.7%)	0.732
Biscuits	57(51.8%)	59(48.8%)	
Bread	18(16.4%)	16(62.0%)	
Cake	4(3.6%)	4(3.3%)	
Drinks			
Freshly squeezed fruit	7(6.4%)	9(7.4%)	0.623
Other fruit juices	34(30.9%)	42(34.7%)	
Coffee or tea	34(30.9%)	40(33.1%)	
Mineral or fizzy drinks	35(31.8%)	29(24.0%)	
Frequency of fruit consumption per week			
> 10	3(2.7%)	1(0.8%)	0.123
7-10	7(6.4%)	6(5.0%)	
4-6	23(20.9%)	30(25.0%)	
1-3	65(59.1%)	57(47.5%)	
0	12(10.9%)	26(21.7%)	

Table 5 shows the consumption of eggs and meat as well as cooking preferences between the two groups. More offshore workers ate eggs (usually fried in oil) and consumed a combination of assorted meat types (offals, beef) than the onshore workers. Offshore workers ate significantly more fish, while onshore workers ate more beef and chicken. Pork is not listed as it is not commonly eaten.

Table 5: Comparison of egg, meat consumption and preferred mode of food preparation.

Variables	Offshore N= 110	Onshore N=121	P-value
	n(%)	n(%)	
How many eggs per week			
0	15(13.6%)	39(32.2%)	<0.01
1-3	58(52.7%)	71(58.7%)	
4-6	30(27.3%)	10(8.3%)	
7-10	5(4.5%)	1(0.8%)	
More than 10	2(1.8%)	-	
Meat consumption			
Mostly a combination of all type	65(59.1%)	61(50.4%)	0.028
Mostly beef	2(1.8%)	9(7.4%)	
Most chicken	7(6.4%)	18(14.9%)	
Most fish	36(32.7%)	33(27.3%)	
Cooking preference			
Boiled	73(64.4%)	73(60.3%)	0.125
Grilled or barbecued	22(21.0%)	19(15.7%)	
Fried	15(14.6%)	29(24.0%)	

Table 6 shows that 49.1% of offshore workers compared to 85.2% of onshore workers ate only two full meals a day or less. Offshore workers therefore had significantly more meals than the onshore. In terms of meal size a similar percentage of offshore workers (98.2%) and onshore workers (97.5%) ate one standard "ration" or less per meal.

Table 6: Comparison of eating patterns and meal size.

Variables	Offshore N= 110	Onshore N=121	P-value
Frequency of meals	n(%)	n(%)	
3 full meals with snacks in between and late meal	-	1(0.8%)	<0.01
3 full meals with snacks in between	1(0.9%)	2(1.7%)	
3 full meals with no	55(50.0%)	15(12.4%)	

snacks in between			
2 full meals with snacks in between	42(38.2%)	72(59.5%)	
Two light meal a day no snack	11(10.0%)	21(17.4%)	
One light meal a day one snack	1(0.9%)	10(8.3%)	
Size of ration			
Two standard ration per meal	1(0.9%)	0(0.0%)	0.272
3/2 ration per meal	1(0.9%)	3(2.5%)	
1 standard ration per meal	67(60.9%)	85(70.8%)	
½ ration per meal	31(28.2%)	26(21.7%)	
¼ ration per meal	10(9.1%)	6(5.0%)	

Table 7 compares the two groups' in terms of the duration of tobacco smoking and the number of cigarettes smoked per day. The table indicates that the majority of workers in both groups never smoked and there were no significant differences in smoking habits.

Table 7: Comparison of smoking habit of the subjects

Variables	**Offshore N= 110**	**Onshore N=121**	**P-value**
	n(%)	n(%)	
Duration of tobacco smoking			
Never	101(91.8)	111(91.7)	0.898
< 5 years	3(2.7)	5(4.1)	
5-10 years	2(1.8)	2(1.7)	
> 10 years	4(3.6)	3(2.5)	
Number of cigarettes a day			
< 5	4(3.6)	3(2.5)	0.113
5-9	2(1.8)	3(2.5)	
10-14	1(0.9)	0(0.0)	
15-20	0(0.0%)	1(0.9)	
0	101(91.8)	114(94.2)	

4.2 Age and years of continuous work, offshore

Figure 1 and 2. shows the age distribution and the years of continuous work at each location. Using categorical data, there was no significance in the two (table 1). There was significant difference between the two locations when the mean ages were compared (table 7).

Figure 1: Age distribution

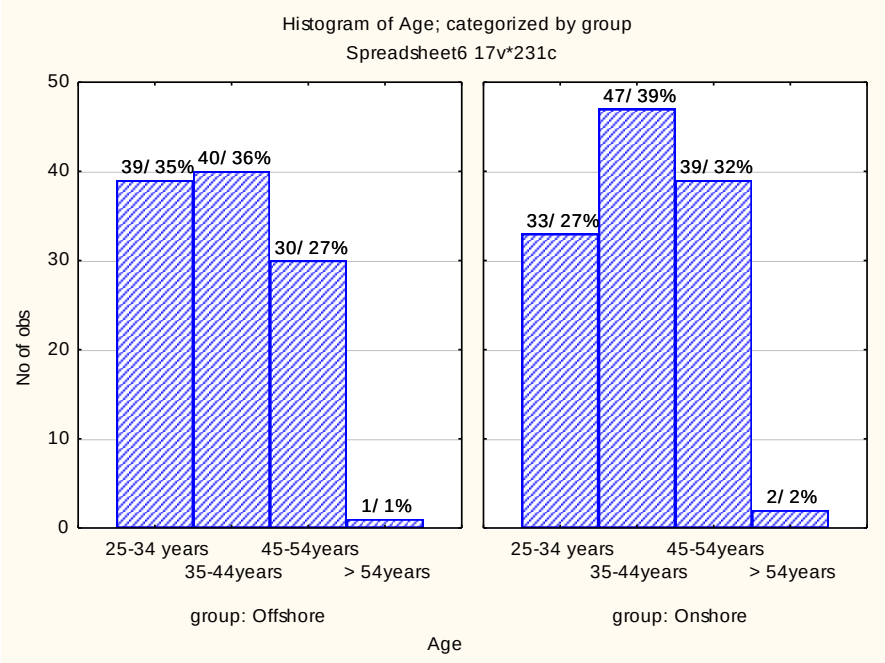
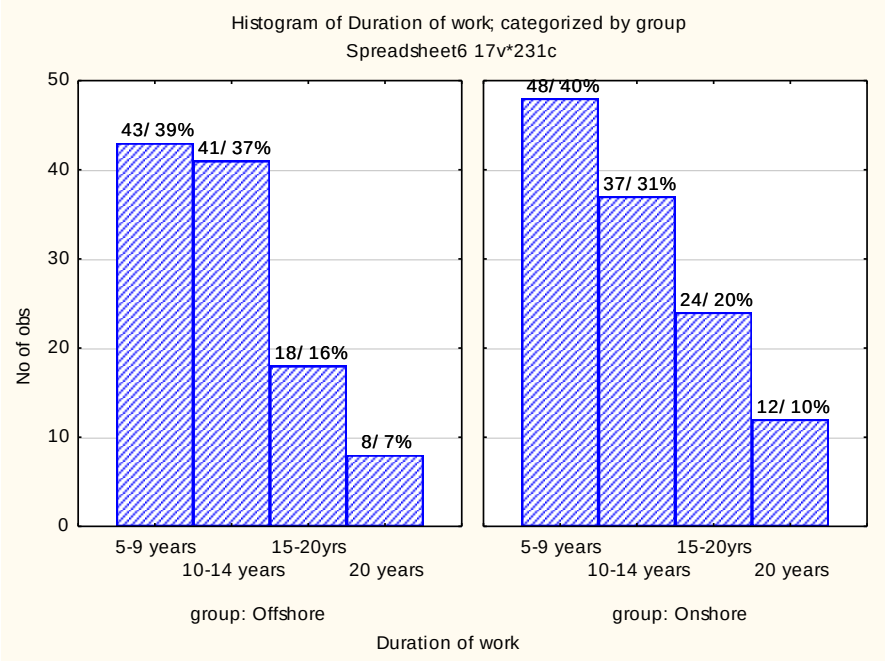


Figure 2; Duration of work



4.3 Anthropometric, biochemical data and blood pressure

Table 7 compares the mean values for continuous anthropometric, biochemical and clinical tests between the two groups.

The mean waist circumference and total cholesterol were significantly higher amongst the onshore workers, although they also had a significantly higher (protective) HDL-cholesterol. The groups did not differ in other measures of overweight/obesity such as waist-hip ratio and BMI.

For the study population of 196, 97 (49%) were overweight (BMI of 25-29.9 kg/$m^{2)}$) while 53 (27%) were obese (BMI ≥30 kg/$m^{2)}$) . Overall therefore 164 (76%) of the population was overweight or obese. When assessed with the waist circumference (>94cm) and the weight to hip ratio (<0.9), 45% and 35% respectively had truncal obesity.
The lipid profile showed that 69% had low HDL, while 30% and 9% had high cholesterol and triglycerides respectively. The low density lipoprotein cholesterol was not calculated for each subject, hence it is not shown on the table 8. The mean value calculated from the mean cholesterol, triglyceride and high density lipoprotein was 3.32 mmole/l; the normal value is <3.4 mmole. Only the value of the population mean for HDL was abnormal.

26% had hyperglycaemia (blood glucose > 5.6mmole/l).

Table 7: Results for continuous variables comparing onshore and offshore petroleum workers.

Variable	**Offshore (n=102)**		**Onshore (n= 101)**		**Mann-Whitney p value**
	Mean	**95% CI**	**Mean**	**95% CI**	
Age	39.1	37.7 – 40.6	41.6	40.1 – 43.0	0.02
Years at location	12.5	11.3 – 13.7	11.8	10.5 – 13.1	0.44
BMI	27.8	27.1 – 28.5	27.5	26.6 – 28.5	0.66
Waist Circumference	91.3	89.4 – 93.2	95.0	92.7 – 97.4	0.02
Hip Circumference	100.8	99.4 – 102.2	102.0	99.9 – 104.1	0.36
Waist-Hip Ratio	0.9	0.89 – 0.92	0.92	0.90 – 0.93	0.38
Fasting Glucose	5.5	5.1 – 5.8	5.1	4.9 – 5.3	0.07
Total Cholesterol	4.3	4.1 – 4.5	4.7	4.5 – 4.9	0.01
Triglyceride	1.24	0.84 – 1.64	0.98	0.89 – 1.07	0.22
HDL-Cholesterol	0.87	0.80 – 0.93	0.99	0.94 – 1.04	0.01
Systolic BP	124.9	122.0 – 127.8	127.1	124.4 - 129.8	0.27
Diastolic BP	75.4	73.4 – 77.3	78.1	76.1 – 80.1	0.05

Table 8 compares the prevalence of known hypertensive and diabetic patients amongst the groups. There were significantly more people with hypertension, diabetes and the metabolic syndrome amongst the onshore workers.

Table 8: Comparison of the prevalence of metabolic syndrome and known hypertension, diabetes

Variables	Offshore	Onshore	P-value
Known Hypertensive			
Yes	11(10.6%)	20(21.6%)	0.038
No	91(89.4%)	79(78.4%)	
Known Diabetic			
Yes	2(1.9%)	9(8.8%)	0.033
No	100(98.1%)	92(91.2%)	
***Metabolic Syndrome**	6 (7%)	14 (14%)	xxx

*IDF criteria

Table 9 compares the the anthropometric and biochemical data between the two locations. Onshore workers had almost double the number of workers with abnormal waist circumference and were more obese (BMI). More Onshore workers were overweight and had high cholesterol level while more offshore workers had elevated TGL, FBG and low protective HDL.

Table 9: Comparison of Offshore and Offshore anthropometric and biochemical data

Variables	**Offshore**	**Onshore**
	%	%
BMI 25-29 56 Kg/m^2	56	42
BMI > 30 Kg/m^2	25	28
WC > 94cm	31	57
TChol > 5.2 mmole/l	15	24
TGL > 1.7 mmole/l	12	6
HDL <1.03 mmole/l	77	62
FBG >5.6 mmole/l	27	21

Table 10 compares offshore and onshore in terms of the percentage of the known hypertensives and diabetics that were not well controlled and were newly diagnosed

Table 10: Comparison of Offshore and Offshore New cases/Level of control of BP and DM.

Variables	Offshore	Onshore
1. HYPERTENSION		
No. of known cases	11	20
Not optimally controlled(>140/90 mmhg)	4 (36%)	8(40%)
New Cases (>140/90 mmhg) [#]	7(63%)	6(30%)
DIABETES MELLITUS		
No of known cases	2	9
Not optimally controlled(FBG >5.6mmole/l)	1(50%)	5(55%)
New cases (≥7mmol/l)*	6(300%)	4(44%)

[#] Based on a single visit measure: There was no follow-up for confirmation
* Were not confirmed with 2-hours post prandial test

Table 11 compares the risk profile of offshore vs. onshore workers using the mean figures of age, lipid profile and blood pressure, and whether the population smokes or is diabetic as variable factors. There is a similar 10 years risk profile for the two study populations using the Framingham risk score.

Table 11: 10yr Framingham Risk Profile Offshore vs. Onshore

Variables	Offshore	Onshore
Mean Age (Yrs)	39.1	41.6
Mean TChol (mmol/l)	4.3	4.7
Mean HDL (mmol/l)	0.87	0.99
Mean Systolic BP	124.9	127.1
Mean Diastolic BP	75.4	78.1
% Smoking	8.2%	8.3%
% Diabetic	2%	9%
Risk (No diabetes No Smoking)	4%	4%
Risk (No Diabetes but Smokes)	7%	7%
Risk (Diabetes but no Smoking)	7%	7%
Risk (Diabetes and Smoking)	10%	10%

Discussion

Main findings of the study

Overall the cardiovascular risk profile of onshore versus offshore workers in the oil industry is worse. In this study the onshore workers had higher rates of increased waist circumference, metabolic syndrome, known diabetes and hypertension and were less physically active. Dietary differences were less marked, but more beef and chicken were consumed by onshore workers, while more fish was consumed by offshore workers. Conversely the offshore workers had lower levels of protective HDL.

Comparison to the literature

The cardiovascular risk profile can be compared with a male urban population study from Jos, Nigeria, 2004[13] The mean age (41.2yrs) was comparable to this study population (40.4yrs). The mean levels of the BMI (22.6 kg/m^2) was less in the urban study and the HDL was better than this study population . The mean systolic, diastolic blood pressure and triglycerides were better in this population. In the Jos study the triglyceride level correlated with the diet of saturated fat. The difference in the lipid profile between the two studies is therefore equivocal and should be interpreted cautiously; working for a company that provides a better access to health care, it is likely that some of the petroleum workers are on lipid lowering drugs, especially alongside the treatment for hypertension and diabetes. This may also account for the slightly better blood pressure profile in the workers. This study did not account for those that were on lipid lowering medications.

Workers in the petroleum industry are markedly more obese than Nigerian males in general as a recent national survey reported a rate of 8.3% vs. 27% in this study[7] The percentage of overweight and obese males in South Africa are less than half and a third, respectively, of the petroleum workers[60]. The percentages of overweight and obese petroleum workers are even higher than that of the black and caucasian populations in the USA. [61] The percentage of overweight males is comparable to that of Norway, UK, Germany, Czech Republic, Croatia and Mexicans residents in the USA[61]

This similar situation was recorded at the North Sea in the past. Recent study showed that age-adjusted BMI values in offshore oil industry workers in the North Sea do not appear to reflect current population trends towards increased BMI levels. This result may be explained by the emphasis later given to health promotion (particularly dietary change) on offshore installations[62].

In South Africa a recent burden of disease study has reported that 87% of type 2 diabetes, 68% of hypertension and 38% of ischaemic heart disease can be attributed to a BMI $\geq$ 21kg/m^2 [63] In this population with even higher rates of overweight/obesity one can predict a similar contribution to the development of chronic diseases.

Another study on the same objective focussed on physical activity. 30% of ischaemic heart disease, and 20% of type 2 diabetes were attributed to physical inactivity . The activity pattern for these South African males that were in the category of 30-44 years; the same age category of the average participant (40years) in this study is as follows:
34% were sufficiently active, 21.3% were insufficiently active and 44.7% were inactive. They were assessed in the domains of work, home, and discretional time[64].
The Petroleum workers were relatively less active with the number of participants being more in the inactive categories in each of the domains. This averaged; sufficiently active(20%), insufficiently active(18%), inactive (62%). The United States of America data for the extreme cases; inactivity in 2005 were, 39.9% for those that spend most of their days sitting and 40% had no leisure time activity. 29.7% were engaged in regular

leisure time activity[65]. This compares more with the South Africa data. Factors that causes this gap in physical activities need to be explored.

Rate of smoking amongst these workers was surprisingly low, at 8% compared to 24.6% for Nigerian males and 36.7% for South African males[60].
It is beneficial to keep the statistics low and motivate the smokers to stop as on the average, male smokers die 13.2 years earlier than non-smokers, it is a powerful independent predictor of sudden cardiac death in patients with CHD, a third of those who receive percutaneous coronary artery vascularization smoke; as well as effects of passive smoking[66].

The 10 year coronary heart disease risk assessment (using Framingham model) for an average person in this study (who is not diabetic, with an age of 40 years, a systolic blood pressure of 125mm/Hg, a total cholesterol level of 4.49 mmol/l, HDL level of 0.9 mmol/l, non-smoker and not on medication to treat hypertension) is 1%. If he is on a medication to treat hypertension the risk is 2% and if he is a smoker, the risk increases to 6%. This tool underscores the additive effect of the risk factors and the need to reduce them. Whereas this average estimate can be considered as good news, the Framingham scoring does not adequately take into account the severity of individual risk factor, e.g. severe hypertention, heavy smoking and hypercholesterolaemia. It can underestimate absolute risk. It normally excludes Diabetes mellitus which on its own confers a heightened risk of CHD[10].

Strengths and limitations of the study
Out of the 400 people randomnly sampled and invited, only 231 completed the questionnaire. It required up to four e-mail reminders at intervals to get a good number of participants. Offshore employees rotate on a shift of two weeks on and two weeks off and given the time frame available to work on the study, it was a great task tracking them, especially to complete the study after filling the questionnaire. It is possible that a few offshore respondents may have just moved from onshore and vice versa, creating a problem with defining the years of work. Where these cases were identified they were excluded to ensure consistency.

Although the questionnaire had gone through peer review and pilot testing for validation of the questions there is still room for improvement to ensure clarity in some of the questions, especially the diet section. The electronically administered questionnaire was most suitable under the circumstance, as one cannot submit without answering all the questions. It was very easy to monitor and the data processing was automatic.

There is the possibility that only those that perceived themselves as healthy may have agreed to participate due to the fear that their answers will be used as an administrative tool to lay off workers. This possibility was minimized by communicating the purpose of the study and reassuring participants about confidentiality.
It could be construed that only very healthy employees are selected to work offshore.The preplacement and periodic medical examination for offshore workers does not exclude on the basis of the presence of coronary disease risk factors. Focus is more on those health

conditions that will constitute a high risk for the worker and the co-workers in the process of work.

Recommendations and conclusions

The prevalence of cardiovascular risk factors in the study population has been determined and the comparison showed a mixed outcome, with onshore employees being more sedentary, having a higher prevalence of truncal obesity, diabetes and hypertension. However, the offshore employees had lower levels of HDL, higher TGL, and a tendency to an unhealthy choice of diet.

As a combined group the obesity and overweight profile is amongst the highest in the world and far above the local and Sub-Saharan region.

Health promotion activity, especially motivation on exercise and diet would encourage an overall improvement in the BMI, and ensure that the present overweight individuals do not become obese in future. This opportunity can be used to reinforce the need for abstinence even with the comparatively low rate of smoking. Preventive measures will be more cost effective than managing actual coronary events against the background of scarce resources[67].

The key finding of this study is that the petroleum industry workers in Nigeria have a burden of CHD risk factors that are higher than the local population and the sub region and which matches the profile of high income countries in Europe and America.
ExxonMobil management should use this information and work with its medical department to ensure that a preventive program for the promotion of cardiovascular health is launched, and accorded the same order of priority in terms of prevention and therapeutic interventions as in those countries.

This study constitutes an overview .which introduces the need for more indepth study, especially into more details of lifestyle- particularly diet and exercise. In a future study work factors like physical workload, stress, shift work, and other indicators like homocysteine and C-reactive Protein can be explored. While addressing the lifestyle aspect of intervention, there is an emerging opportunity and added advantage in offering genetic cardiovascular risk assessment to employees and their families to complete the picture

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