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Original Research Article

Effect of Gasoline and Paint Products on Cardiac Markers and Blood Glucose

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Abstract

Hydrocarbons (benzene, toluene, ethyl benzene and xylene (BTEX) found in gasoline and organic solvents are ubiquitous in the environment, and are known to have toxic effects in human system. This study therefore investigated in workers occupationally exposed to gasoline and paint products, the levels of glucose, apoprotein-B100 and cardiac troponin-I as indices of diabetes and cardiac functions. A total of 162 subjects were recruited for this study; (56 gasoline pump attendants and 56 paint factory workers) and 50 subjects as control. Sample collected were used for the estimation of Fasting blood sugar (FBS) using spectrophotometer; Apoprotein-B100 and troponin-I using Enzyme linked immunosorbent assay (ELISA) techniques. APOB-100 was significantly higher (P<0.05) in the gasoline workers (2.30±0.85) than in the paint workers (1.86±1.12) and control subjects (1.90±0.77). The mean Troponin-I level was significantly higher in the gasoline workers (10.35±4.87) than in the paint workers (4.65±2.71) and in control group (8.14±5.13) (P=0.000). The mean glucose level, body mass index, systolic and diastolic blood pressures were of non-significant difference (P>0.05) across the groups. The correlation coefficient between Apo-B100 and Troponin-I with the duration of exposures for gasoline and paint products showed non-significant negative correlations (P>0.05) respectively. Our result finding is suggestive of significant alterations in the serum levels of Apo-B100 and Troponin-I as evidently shown by the significant elevations of APO-B100 and Troponin-I in workers exposed to both gasoline and paint products than in control subjects. Thus, workers exposed to gasoline and paint products could be predisposed to cardiovascular diseases at later age.

Keywords: Troponin-I, APO-B100, Blood Glucose, Cardiovascular markers, Gasoline and Paint products

INTRODUCTION

Increased health and safety risks have characterized most occupations worldwide, with some occupations and occupational environments posing greater risk to human health than others (Asuquo and Ekpenyong, 2017). Workers around the world are faced with various kinds of work-place hazards. According to the International Labour Organization, at least 2 million of the estimated 2.7 billion workers die every year from work-related ill-health and injuries, about 160 million people suffer from work-related diseases (International Labour Organization, 2007). Petroleum streams represent an array of substances, many with common physical/chemical and toxicological properties that arise from the complexity of the natural source material oils and the variety of products that are formed during the refining and downstream processes (McMillen *et al.,* 2001). Epidemiological data indicates that petrochemical ndustries provide an exposure scenario that increases the vulnerability of workers to gasoline-related health risks (Azari *et al.,* 2012).

Gasoline is a volatile and inflammable petroleum-derived liquid mixture primarily used for internal combustion of machines (Micyus *et al.,* 2005). It consists of hydrocarbons (aromatic, saturated and unsaturated), and non-hydrocarbons (N, S, O_2, vanadium and nickel) (Lewne *et al.,* 2006). Among the numerous constituents of petroleum products, gasoline constituents (benzene, toluene, ethyl benzene and xylene (BTEX) are designated as the most toxic compounds to humans (Azari *et al.,* 2012). They constitute the volatile fractions of gasoline that are gradually released into the air and may exist in both the vapor phase and the water-soluble fraction, due to their high vapor pressure and solubility in water. Workers may be exposed intentionally or accidentally through inhalation, ingestion, or via dermal routes.

Paint is any liquid, liquefiable or mastic composition that, after application to a substrate in a thin layer, converts to a solid film. It is most commonly used to protect, color, or provide texture to objects (Mayell, 2004). Paint typically consists of pigments, resins, organic solvents and additives (British Coating Federation, 2006). Paint products are widely used in industry to provide surface coating for protection against corrosion, for appearance as electrical insulation, for fire retardation and for other special purposes. Paints can be applied by a variety of processes including brush, roller, dip, flow, conventional air spray, airless spray, disk spraying and powder coating. According to recent studies, occupational exposure to paint may cause an increased risk of several kinds of cancer, including lung, bladder and pancreas cancer and lymphatic and hematopoietic tumors (Brown *et al.,* 2002). These findings are consistent with the 1989 report issued by the International Agency for Research on Cancer, which classified painting as an occupationally related cause of cancer and provided further evidence that the risk of certain cancers is increased by exposures in the paint manufacturing process (International Agency Research Cancer, 1989). Paint manufacture workers are potentially exposed to the chemicals found in paint products although the patterns and levels of exposure to individual agents may differ from those of painters (Hugo *et al.,* 2011). Paint industry workers are exposed to complex mixtures of organic solvents (benzene, toluene, xylene, ketones, alcohols, esters, and glycol ethers), pigments (heavy metals), extenders, binders, additives, and many other compounds with potential mutagenic properties, such as phthalic acid and chlorophenols (Çok *et al.,* 2004). The increasing use and diversity of solvents raises concern about possible risks in occupational exposure. The possibility of cytogenetic damage in various occupations exposed to organic solvents has been discussed in several papers (Heuser *et al.,* 2005; Heuser *et al.,* 2007; Madhavi *et al.,* 2008). Some of these solvents such as benzene, ethyl benzene, toluene, and xylenes (BTEXs) are known for suspected carcinogens and need effective control (Haro-García *et al.,* 2012).

Gasoline and paint contain similar organic solvents by the presence of BTEX in both chemicals respectively. Human exposure to BTEX, both through inhalations, dermal routes or ingestion, can have serious health impacts, such as neurological diseases, cancers, and teratogenic effects (Chauhan *et al.,* 2014). This is of major concern as 50% of BTEX inhaled by humans over a person's lifespan is actually absorbed into the body (Chauhan *et al.,* 2014).

Several epidemiological studies have reported a statistical relationship between exposure to gaseous air pollutants and increased rates of cardiovascular morbidity and mortality (Goldberg *et al.,* 2001 and Pope *et al.,* 2004). Exposure to heavy metals has been shown to be associated with middle-term and long-term health risks such as high blood pressure and brain disturbances (Hifsa *et al.,* 2009). Existing data shows that long-term exposure to organic solvents is significantly associated with a higher prevalence of hypertension (Wiwanitkit, 2008). Similarly, (Uboh *et al.,* 2008) found a significant increase in the atherogenic index of plasma (AIP) in animals exposed to organic solvent vapors. Consequently, exposure to organic solvents could be associated with the risk of atherosclerosis and hence cardiovascular disease.

Cardiovascular disease (CVD), a class of diseases that involve the heart or blood vessels, includes coronary artery diseases (CAD) such as angina and myocardial infarction (commonly known as a heart attack) (Shanthi *et al.,* 2011). Coronary artery disease, stroke, and peripheral artery disease involve atherosclerosis. Cardiovascular diseases are the leading cause of death globally. It is estimated that 90% of CVD is preventable (McGill *et al.,* 2008). High blood pressure results in 13% of CVD deaths, while tobacco results in 9%, diabetes 6%, lack of exercise 6% and obesity 5% (Global Burden Disease, 2013).

Apoprotein B is a large amphipathic glycoprotein with 2 isoforms: Apo B-100, which is synthesized in the hepatocytes, and apo B-48, an abridged version that is also derived from the apo B-100 gene (but from a modified messenger RNA (mRNA) transcript and synthesized in the small intestine (Segrest *et al.,* 2001). It is now evident that an increased serum Apo B-100 concentration is an important coronary heart disease (CHD) risk factor because it is a component of all atherogenic or potentially atherogenic particles (Barter *et al.,* 2006) including very-low-density lipoprotein, intermediate-density lipoprotein, low density lipoprotein, and lipoprotein(a), and each particle contains one molecule of Apo B. Thus, Apo B provides a direct measure of the number of atherogenic lipoprotein particles in the circulation. Cardiac troponins are proteins found in cardiac muscle cells, which can be released into the bloodstream as a result of myocardial injury (Otto, 2016). Cardiac troponin-I is a novel biomarker of myocardial injury and ischaemia. Cardiac troponin has been well described as the preferred biomarker for diagnosis of myocardial infarction due to its high sensitivity and specificity for myocardial injury. However, the use of cardiac troponin-I as prognostic biomarker for the primary assessment of cardiovascular risk in asymptomatic patient has only recently been described (Hoff *et al.,* 2016).

Work-related ill-health caused by exposure to chemical agents (organic solvents) has become a major concern in the workplace (Cezar-Vaz *et al.,* 2012). This scenario carries significant public health concern and has been an important issue in occupational medicine due to the potential adverse effects of occupational exposure to toxic organic solvents. Although some of the health and environmental hazards of gasoline and paint had been previously documented through epidemiological and experimental studies (Okoro *et al.,* 2006 and Sadiqua and Rathna, 2012) however, the areas of cardiovascular functions and diabetes have received less attention. Thus, this study is set to assess the cardiovascular biomarkers (Apoprotein B-100 and Troponin-I) and FBS in workers occupationally exposed to gasoline and paint in Nkpor-Agu and environs, Anambra State.

Statement of problem

The knowledge of the interactions between work and health is fundamental in understanding and practicing occupational health (Aliyu and Shehu, 2006). Gasoline and paint contain several toxic hydrocarbons which include aliphatic (straight chain) hydrocarbons and aromatic (benzene-containing) hydrocarbons (Goldstein *et al.,* 2013) that get into the body system through the nasal, oral and dermal routes. Petrol pump attendants and paint factory workers in the developing countries are particularly vulnerable to the hazardous effects of these organic constituents because they have to manipulate the solvents and as a result inhale their vapors and particulate matters, during their daily work. In this resource-limited country, regulatory and protective mechanisms are inadequate.

Justification of the study

Among the numerous constituents of gasoline and paint products, benzene, toluene, ethyl benzene and xylene (BTEX) are designated as the most toxic compounds to humans (Azari *et al.,* 2012). There is paucity of data on the nature and degree of hazard involved in occupational exposure to gasoline and paint. Measures that will reduce or eliminate hazards as well as create harmony between man and his job can never be designed if the dangers the workers are prone to are not unraveled. Therefore, the pertinence to assess the health consequences of artisan workers occupationally exposed to gasoline and paint products arises. This study will focus on the areas of thyroid and cardiac function in these subjects. The findings of this research work will provide critical data that will inform future evidence-based evaluation and intervention programs, for occupational safety and public health policies.

Aim

To assess the cardiovascular and diabetic status of workers occupationally exposed to gasoline and paint products, in Nkpor-agu and environs, Anambra state using APO-B100, Troponin-I and Fasting Blood Sugar (FBS) as markers respectively.

MATERIALS AND METHOD

Materials

ELISA machine (Mindray MR-96A microplate reader, Shenzhen, China) Mindray BS 240 (Auto-chemistry analyzer).

Methods

Study area

This research was conducted at Nkpor-Agu and environs, Anambra State, Nigeria. Nkpor-Agu is a densely populated suburban area, surrounded by increasing number of gasoline stations and paint factories; with residential houses, schools, markets and offices sited close to these industries.

Study design

This is a cross-sectional study designed to assess the diabetic status and cardiovascular function in workers occupationally exposed to gasoline and paint products in Nkpor- Agu and environs, Anambra State, Nigeria. A total of 162 adult volunteers aged 18-60years was recruited for this study using stratified random sampling technique, which comprised of 112 individuals as test group (56 subjects as gasoline pump attendants and 56 subjects as paint factory workers) and 50 subjects as control. Information on socio-demographic, medical history, lifestyle, nature and duration of job was obtained using a questionnaire.

Sample size

The population size was determined using Yaro Yamane formula (Osemeke, 2012).

$n= N/ (1+ N (e)^2)$

Where;

n= sample size

N= finite population (270)

e= error margin (0.05)

1= unity (constant)

n= 161

Ethical clearance:

The ethical approval for this research was obtained from the Ethical Committee; Nnamdi Azikiwe University Teaching Hospital, Nnewi. Informed consent was sought and obtained from the subjects prior to the study using a well structured questionnaire.

Inclusion criteria:

A) Individuals occupationally exposed to gasoline and paint products.

B) Individuals within the age range of 18-60years.

B) Individuals with matching ages not occupationally exposed to these products.

Exclusion criteria

A) Individuals outside the age range of 18-60 years.

B) Subjects with history of chronic diseases such as Chronic Obstructive Pulmonary Disease, Diabetes mellitus, Hypertension and Thyroid disorders prior to industrial exposure.

C) Smokers, chronic alcohol drinkers and subjects on medications likely to affect the results e.g carbamazepine, phenytoin, etc.

Specimen collection

Seven milliliter (7ml) of fasting whole blood was collected from the subjects using the standard venipuncture technique and the blood samples dispensed into fluoride oxalate and plain sample containers for glucose and cardiac markers estimation respectively. The samples in plain containers were allowed to clot and centrifuged at 5000rpm for 5 minutes. The serum was separated and used for the assay of Troponin-I and Apo B-100 levels while the plasma samples was used for glucose estimation.

Estimation of Troponin-I

The method of Giuliani *et al*., (1999) was used for the assay of Troponin-I. This is essentially an Enzyme Linked Immunosorbent Assay procedure.

Principle

The kit uses a double-antibody sandwich enzyme-linked immunosorbent to assay Troponin-I (Tn-I) in serum. The standard, test sample and HRP-labeled Troponin-I antibodies are added to wells which are Pre-coated with Troponin-I antibody. After incubation and washing to remove the uncombined enzyme, Chromogen Solution A and B were added. The color of the liquid changed into blue. At the effect of acid, the color finally becomes yellow. The color change is measured spectrophotometrically at a wavelength of 450 nm. The concentration of Troponin-I (Tn-I) in the samples is then determined by comparing the O.D. of the samples to the standard curve.

Estimation of Apolipoprotein B-100 levels

The method of Cho *et al*., (2012) was used for the determination of Apolipoprotein B100. This is essentially an Enzyme Linked Immunosorbent Assay procedure.

Principle

The kit uses enzyme linked immunosorbent assay-double antibody sandwich principle to assay Apoprotein B100 (Apo- B100) level in the sample. The microelisa stripplate provided in the kit is coated with purified Apoprotein B100 (Apo- B100) antibody to make solid-phase antibody, when Apoprotein B100 (Apo- B100) in serum is added to the wells, it combines with Apoprotein B100 (Apo- B100) antibody labeled by HRP to form antibody - antigen - enzyme- antibody complex. After washing completely to remove the uncombined enzyme, Chromogen Solution A and Chromogen solution B is added, the color of the liquid changes into the blue and at the effect of an acid, the color finally becomes yellow. The color change is measured spectrophotometrically at a wavelength of 450 nm. The concentration of Apoprotein B100 (Apo- B100) in the samples was then determined by comparing the O.D. of the samples to the standard curve.

Plasma glucose estimation (FBS)

Estimation of plasma glucose was done using glucose oxidase according to the method of Trinder, (1969).

Principle

Glucose oxidase catalyze the oxidation of glucose to gluconic acid and hydrogen peroxide. The hydrogen peroxide produced is then broken down to oxygen and water by the enzyme; peroxidase. Oxygen then reacts with an oxygen acceptor 4-aminophenazone in the presence of phenol to form a pink coloured complex whose intensity is proportional to concentration of glucose in the sample.

Statistical Analysis

Statistical package for social sciences version 23.0 was used for data analysis. Data obtained was analyzed using the Analysis of Variance (ANOVA). Results were deemed significant at $P<0.05$. Correlation studies were performed using the Pearson's correlation coefficient.

RESULTS

Table 1 shows the mean levels of APOB-100, TROP-I and Glucose in gasoline workers, painters and control subjects. The results showed a significant increase in the mean APOB-100 levels (2.30±0.85) in the gasoline workers but a significant decrease in the paint workers (1.86±1.12) relative to the control subjects (1.90±0.77); ($P<0.025$) respectively. The post hoc test showed that the mean APOB-100 level was significantly higher in the gasoline workers compared to the paint workers ($P<0.013$). The mean TROP-I level was significantly increased in the gasoline workers (10.35±4.87) but significantly decreased in the paint workers (4.65±2.71) relative to the control group (8.14±5.13; P=0.000). The mean glucose level was non-significantly lower in the control group (82.62±9.61) compared to the test groups (P= 0.251). The post hoc test also showed a non-significant decrease in the mean glucose levels of the gasoline workers compared to painters; (p=1.000).

Table 2 shows the mean age and blood pressure of gasoline workers, painters and control subjects. The results showed a significant decrease in the mean age of gasoline workers (26.86±5.05) but a significant increase in the paint workers (30.14±6.64) relative to the control group (28.46±6.09); (p=0.016) respectively. The post hoc test indicated that the mean age was significantly increased in paint workers compared to the gasoline workers; (p=0.012). Conversely, a non-significant decrease in the mean systolic blood pressure of gasoline workers (117.52±6.24) and a non-significant increase in the paint workers (119±6.35) relative to the control group (117±6.36) was observed respectively; (p=0.216). From the post hoc tests, the mean systolic blood pressure was non-significantly higher in the painter workers relative to the gasoline workers. Similarly, there was a non-significant increase in the mean diastolic blood pressure of the gasoline workers (72.14±7.81) and painters (74.61±9.77) when compared to the control subjects. However, the post hoc test showed the mean diastolic blood pressure was non-significantly higher in the paint workers relative to the gasoline workers (p=0.359).

Table 3 shows the mean weight, height and body mass index of gasoline workers, painters and control subjects. There was a non-significant decrease in the mean weight of gasoline workers (69.21± 8.36) and paint workers (67.00±9.47) respectively; relative to the control group (70.10±10.59), (p= 0.220). Similarly, a non-significant decrease was observed in the mean height of the painters (1.58±0.12) when compared to that of gasoline workers (1.59±0.11) (p= 0.528) and control subjects (1.59±0.12) (p=0.464) respectively. However, a non-significant difference was observed in the mean height of gasoline workers (1.58±0.12) compared to the control subjects (1.59±0.12) (p=0.905). A non-significant difference was observed in the mean body mass index of gasoline workers (27.65±4.75) and painters (27.18±4.58) relative to the control subjects (27.82±4.59), (p=0.761).

Table 4 shows the pearson correlation of the levels of APOB-100 and TROP- I with duration of exposure in gasoline workers. The levels of APOB-100 and TROP-I showed non- significant correlation with the duration of exposure to gasoline, in these gasoline workers.

Table 5 shows the correlation of the levels of APOB-100 and TROP- I with duration of exposure to paint products in painters. The levels of showed non-significant correlations of the levels of APOB-100, and TROP-I with the duration of exposure to paint products observed in the painters.

Table 1. Levels of APOB-100, TROP-I and Glucose in gasoline workers, painters and control subjects

Groups	Total (n)	TSH (µIU/ml)	T3 (ng/ml)	T4 (µg/dl)
Gasoline (1)	56	2.30 ± 0.85	10.35 ± 4.87	84.69 ± 9.17
Painters (2)	56	1.86 ± 1.12	4.65 ± 2.71	85.66 ± 9.75
Control (3)	50	1.90 ± 0.77	8.14 ± 5.13	82.62 ± 9.61
F-test		3.787	24.397	1.395
p- value		0.025	0.000	0.251
1 vs 2 (p- value)		0.013	0.000	1.000
1 vs 3 (p- value)		0.012	0.010	0.790
2 vs 3 (p- value)		0.028	0.000	0.307

Mean ± SD of triplicate readings.
Key: APOB-100= Apolipoprotein B100

Table 2. Mean Age, Systolic and Diastolic blood pressure of gasoline workers, painters and control subjects

Groups	Total subjects (n)	Age (Years)	Systolic BP (MmHg)	Diastolic BP (MmHg)
Gasoline (1)	56	26.86 ± 5.05	117.52 ± 6.24	72.14 ± 7.81
Painters (2)	56	30.14 ± 6.64	119.00 ± 6.35	74.61 ± 9.77
Control (3)	50	28. 46 ± 6.09	117.56 ± 6.36	71.42 ± 7.06
F-test		4.254	1.432	2.174
p- value		0.016	0.216	0.117
1 vs 2 (p- value)		0.012	0.280	0.359
1 vs 3 (p- value)		0.507	1.000	1.000
2 vs 3 (p- value)		0.446	1.000	0.153

Mean ± SD of triplicate readings.

Table 3. Demographic and anthropometric characteristics of the study and control subjects

Groups	Total subjects (n)	Weight (kg)	Height (m)	BMI (Kg/m^2)
Gasoline (1)	56	69.21 ± 8.36	1.59 ± 0.11	27.65 ± 4.75
Painters (2)	56	67.00 ± 9.47	1.58 ± 0.12	27.18 ± 4.58
Control (3)	50	70.10 ± 10.59	1.59 ± 0.12	27.82 ± 4.59
F-test		1.531	0.319	0.273
p- value		0.220	0.727	0.761
1 vs 2 (p- value)		0.654	0.528	0.594
1 vs 3 (p- value)		1.000	0.905	0.852
2 vs 3 (p- value)		0.283	0.464	0.481

Mean ± SD
Key: BMI= Body mass index

Table 4. Correlation of the levels of APO B and TROP- I with duration of exposure in gasoline workers

Gasoline	r	p-value
Duration vs APOB-100	-0.067	0.623
Duration vs TROP-1	-0.133	0.329

Table 5. Correlation of the levels of APO B and TROP- I with duration of exposure in painters

Gasoline	r	p-value
Duration vs APOB-100	-0.060	0.660
Duration vs TROP-1	-0.175	0.196

DISCUSSION

Exposure to solvents is ubiquitous in modern industry and the workers are commonly exposed to mixtures of solvents (Gupta *et al.,* 2012). The health impact of workplace solvent exposure remains an issue of substantial interest and concern to occupational health professionals. Exposure to different organic solvents has been reported to cause adverse effects on the functional integrity of different tissues in the biological systems (Uboh and Ufot, 2013). The impact of health and environmental hazards, associated with the constituents of gasoline and paint, on occupationally exposed workers has been recorded over the past few decades. Since the organic components of gasoline and paint includes BTEX compounds which has an inherent toxic potential (Asuquo and Ekpenyong, 2017), workers at gasoline stations and paint factories are the population at greatest risk of being simultaneously exposed to the synergistic and/or additive adverse effects of the gasoline and paint constituents respectively.

This study also revealed there was a significant increase in the mean values of APOB-100 and TROP-I among the gasoline exposed workers compared to the control subjects. This report is in agreement with the findings of Uboh *et al*. (2008) which reported a significant increase in the atherogenic index of plasma (AIP) and atherogenic dyslipidaemia in animals exposed to gasoline vapors. Similarly, Poklis (1977) and Litovitz (1988) reported an increased cardiac sensitization to circulating catecholamines, leading to severe arrhythmias and death, in humans exposed to high concentrations of gasoline. Exposure to gasoline vapors could be associated with the risk of atherosclerosis and hence cardiovascular disease. This is consequent of their high level of lead, xylene, toluene and benzene content (Mohammadi *et al.,* 2012). The exact mechanism is unclear but studies suggest the bioactive gasoline metabolites may induce an oxidant/antioxidant imbalance, generate the ROS, cause lipid peroxidation and hence increase oxidative stress (Yadav and Seth, 2001 and Künzli and Tager, 2005). This results in the development of atherosclerotic cardiovascular disease. Lead exposure has also been linked to dyslipidemia and atherosclerosis (Reed *et al.,* 2017). The cardioprotective antioxidant activity of high-density lipoprotein is partially mediated by paraoxonase activity, an enzyme that is closely bound to the high-density lipoprotein particle and involved in inhibition of low-density lipoprotein (LDL) oxidation. Lead as well as other metals can inactivate paraoxonase and, therefore, promote LDL oxidation and atherosclerosis development (Li *et al.,* 2006 and Pieters *et al.,* 2012). However, in contrast to the gasoline exposed subjects, a significant decrease in the mean levels of APOB-100 and TROP-I was observed among the paint exposed workers. Although there was a significant decrease in the mean values obtained from the paint exposed group and the control, however the values were still within the normal range. The significant decrease observed in the paint exposed group relative to the gasoline exposed group could be attributed to the lesser proportion of BTXs found in paint as against the higher content found in gasoline; and the decreased dose of inhalation common in the painters, who not only wear protective coats but gloves and safety boots during the course of their daily work (Hugo *et al.,* 2011) thus reducing the strength and length of exposure to these organic solvents. It is suggested that the slight increased values found in control group than in paint exposed group in this study are associated with amount of energy consumption rather than exposure to organic solvents, since they were the unexposed group. Previous studies into negative health symptoms observed in paint factory workers/painters have reported neuropsychological symptoms including impairments of memory, perceptual speed, manual dexterity (Elofsson *et al.,* 1980) and psychomotor coordination (Hane *et al.,* 1977). Olufunsho *et al*. (2014) reported a twice significant increase in the mean lead (Pb) concentration of urine samples obtained from paint factory workers than those of non-factory workers.

This study also revealed non-significant increase in the mean value of glucose among the test subjects compared to the control group. This is in contrast with the findings of Ari *et al*. (2004) which reported a significant difference in mean glucose level of workers exposed to organic solvents. However, in line with this study, they also indicated the values were within the normal range. The difference is suggested to have been caused by a long-term exposure to the organic solvents (Ari *et al.,* 2004). This study also reported a significant decrease in the mean age of the gasoline exposed subjects compared to the paint exposed workers. However, there was no significant difference in the mean age of the test groups relative to the controls. The difference in age between the test subjects was as a result of the disparity in the age brackets found in both occupations. Most of the gasoline station workers were in their mid-twenties' where as the painters was in their early thirties'.

There was also non-significant difference in the mean systolic and diastolic blood pressure, height, weight and BMI (anthropometric parameters) among the test subjects compared to the control subjects. This is in agreement with the findings of Johnstone *et al*. (2005) who also found no significant difference between the mean weight, height and BMI of automobile and railway spray painters compared to the control subjects. Another study also reported no significant difference in different groups of industrial vibrating tool operators **(**Johnstone *et al.,* 2005**)**. However, Ki-Woon *et al*. (2012) reported that the anthropometric values in the control group were significantly higher than the test group in workers occupationally exposed to chemicals.

Also in this study, the levels of APOB-100 and TROP-I showed no significant correlation with the duration of exposure to gasoline. This tallied with the findings of another study which indicated creatinine levels negatively correlated with duration of exposure to organic solvents (Shigeki *et al.,* 2016). However, APOB-100 and TROP-I showed non-significant inverse relationship with the duration of exposure to paint in the exposed workers. This agrees with Chen *et al*. (1991) and Oduola *et al*. (2015) who reported no association between the liver function parameters and exposure among paint workers. Similarly, Hoeck *et al*. (2000) and Aril *et al*. (2004) reported there was no correlation between duration of exposure and kidney function parameters in workers exposed to organic solvents. Comparatively, this research demonstrated that both gasoline and paint showed similar effects on the thyroid parameters of the subjects under study, which may be due to their similar chemical constituents while gasoline proved to be more deleterious to cardiovascular function compared to paint. Hence, exposure to organic solvents (BTEX) present in both gasoline and paint could be relatively associated with a state of T3 thyrotoxicosis and atherosclerosis with a resultant cardiovascular dysfunction on the long run.

CONCLUSION

Our result finding is suggestive of significant alterations in the serum levels of Apo-B100 and Troponin-I as evidently shown by the significant elevations of APO-B100 and Troponin-I in workers exposed to both gasoline and paint products than in control subjects. Thus, workers exposed to gasoline and paint products could be predisposed to cardiovascular diseases at later age. We thereby recommend that adequate policies and strategies should be put in place to ensure that safety regulations are heeded to by the petrochemical industries. Moreover, further research need to be conducted, especially to assess the threshold, frequency or dose of the organic solvents exposure that would yield physiological/ organ dysfunction.

Contribution to knowledge

This study established that exposure to organic solvents present in both gasoline and paint could be relatively associated with cardiovascular diseases.

Limitations

This study is subject to some limitations. There were no means to measure the individual dose of the organic solvents inhaled and/or exposed to; by the subjects. More so, there was an age difference between the two groups of subjects involved.

Conflict of interest

The authors declare no conflict of interest in this study.

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