

Assessment of Cadmium, Lead and Mercury Levels on Petrol Attendants and Welders in Obio-Akpor and Phalga in Rivers State

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ABSTRACT

Introduction: Heavy metals are naturally occurring elements with the characteristics features of a high atomic weight, density up to 5 times greater than that of water or even more, toxic or poisonous even at low concentration and/or exist as elemental metal and methyl metal. Study aimed at assessing the blood concentrations of these environmental toxins in the chosen study group.

Material and methods: Cadmium, Lead and Mercury levels were assessed on blood sample of (25) Petrol Attendants and (25) welders in Port Harcourt, Rivers State, Nigeria. A corresponding twenty (20) apparently health subjects were used as controls. Blood samples were collected and analyzed by atomic absorption spectrophotometry. Graph pad prism version 5.03 was used for comparative analysis and test of significance was at $p < 0.05$.

Results: For cadmium, comparative analysis of control/Petrol Attendants, results showed a significant increase ($p < 0.05$) for those exposed to petrol vapour. Comparative analysis of control/welders showed no significant change ($p < 0.05$). Also comparative analysis of Petrol attendants/welders result showed no significant difference at ($p < 0.05$). And analysis of control/petrol attendants/welders was also significantly higher ($p < 0.05$) against the control. Lead result analysis also revealed statistical significance ($p < 0.05$) higher in welders, petrol attendants compared to control while the result of mercury levels showed no significant difference between the test subjects and the controls.

Conclusion: The results therefore showed that exposure to petrol vapour have the potential to increase the level of metals in the body. This could pose a threat to the overall health of the individual. These effects, from the study, are connected to the duration of exposure. Precaution is therefore needed when in contact with these compounds.

Keywords: Cadmium, Lead, Mercury, Petrol Attendants, Welders

INTRODUCTION

They are widely in distribution, been used for industrial, domestic, medical, agricultural and technological purposes.^{1,2} Human sustained exposure to environmental interactions lead to their potential health effects on both the environment and humans.

Petrol, also known as gasoline in some countries, is produced from crude petroleum through the distillation and refining process. According to the US Agency for Toxic Substances and Disease Registry (ATSDR), there are typically more than 150 chemicals in petrol, including small amounts of benzene, toluene, xylene, ethylbenzene, and trace amounts of some contaminants, such as cadmium and lead. Petrol

has a high vapour pressure and rapidly evaporates at normal ambient temperatures. Small spills of petrol in filling stations can therefore contribute to significant air concentrations. For example, it has been reported that the concentration of petrol in air at a filling station during the filling of an automobile petrol tank was up to 99 ppm.³

Petrol is one of the fractionated products of crude oil used for fuelling automobiles and some power generating machines. It is made from processed crude oil and is a pale brown liquid with a strong odour. It can form explosive mixture in air. It is very complex, volatile and inflammable with many organic and inorganic saturated and unsaturated hydrocarbons containing 3 to 12 carbons.^{3,4}

The constituents depend on the location of origin, processing techniques, the season and the additives added (anti knock) to enhance performance. Its composition also varies with the source of crude petroleum, the manufacturer and time of the year. Commonly, gasoline contains about 62% alkanes, 7%alkenes and 31% aromatics, alcohols, ethers and additives.^{4,5}

Studies have shown that chronic exposure to gasoline pollutant gases is more common in oil drillers, refinery workers, petrochemical industry workers, refuel station attendants, drivers and motor mechanics.^{3,5} Increase plasma levels of some constituents of gasoline like benzene, lead and cadmium is found to be associated with increase reactive oxygen production and the chronic diseases associated with it including renal impairment⁶ Other constituent of gasoline associated with renal diseases is alkylbenzenes (Toluene and xylene). They are single ring aromatic hydrocarbons with one or more saturated aliphatic side chains. They are mainly absorbed by inhalation and through the skin. Studies have found association of these compounds with various chronic diseases such as kidney diseases, hearing loss, CNS disorders, liver, and heart diseases.^{6,7,8}

Other components of petrol implicated in nephrotoxicity are the organic compounds of leads such as tetramethyl and tetraethyl lead, which are alkyls of lead and were developed

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as octane enhancers. Tertiary butyl alcohol (TBA) has also been found to be associated with nephropathy and renal tubular acidosis. Some studies have also found them to be neurotoxic.^{9,10} Other effects found by research studies are, haematologic alterations, hypertension, growth and development deficiencies, and impairment of immune system responses.⁷ Risk of occupational exposure to gasoline is found even in well-organized setting of gasoline stations. This risk could even be higher among roadside dispensers of gasoline in Nigeria. They often use their mouth to create vacuum pressure to dispense the products through pipes into receivers. Like other known xenobiotics, the chemical pollutants from gasoline vapour may be metabolically transformed into various metabolites in the body. Some of these metabolites may be very reactive, interacting in various ways with the metabolizing, transporting and excretive tissues to elicit toxic effects.⁷

Cadmium is a soft, silver-white metal found naturally at low levels in rocks and soil. It is used in nickel-cadmium batteries, electroplating as a component in metallurgical and brazing – soldering alloys, in pigments, and as stabilizer for plastics. Further environmental sources are smelting of other metals like Zn, burning of fossil fuels and waste materials (often deposited as solid waste), use of high phosphate and sewage sludge fertilizers. Cd is a toxic metal with elimination half-life of 10-30 years, accumulating in the body especially in the kidneys. Its urinary excretion is a biomarker of its body burden. The kidney being its major target organ, the first manifestation of Cadmium toxicity is tubular dysfunction with increased urinary excretion of calcium and low-molecular weight proteins such as β 2-microglobulin, acetyl- β -D-glucosaminidase (NAG), retinol-binding protein and α -1-micro-globulin. It is a major cause of end-stage renal disease. Long-term exposure has been associated with bone diseases (such as osteomalacia and osteoporosis), alteration in lung function, lung cancer, prostate cancer and renal cancer in exposed workers. Much of Cd toxicity is attributable to its ability to substitute for Zn in biological reactions.¹¹ Mercury and Lead has also been reported to affect minerals of the body system in inducing toxicity just like cadmium especially in developing countries like Nigeria were exposure to heavy metals vis-a-vis crude oil exposure and petrol stations.^{12,13,14,15,16} Zn is an essential metal required for the synthesis of DNA, RNA and protein as well as for the enzymatic activity of Zn-containing enzymes. Zn has been shown to reduce the carcinogenic effects of Cd in animal models. This supports the antagonistic relationship between Cd and Zn. Cadmium is not known to offer any biological benefit to man. In contrast, following an array of experimental and epidemiological evidence, its carcinogenicity to man has been proven. It inhibits apoptosis, induces single-strand DNA breaks, exerts inhibitory effects on DNA repair system, disrupts cell adhesion and activates proto-oncogenesis. Chronic obstructive airway disease has been associated with long-term inhalation of heavy metals like mercury, lead and Cadmium.^{18,19,20,21} By chronic cadmium exposure, effects occur mainly on the kidneys, lungs,

and bones.²² A relationship has been established between cadmium air exposure and proteinuria, characterized by an increase in the excretion of low molecular weight proteins, such as β 2-microglobulin in urine.¹⁴

Lead has been used since prehistoric times; it is a versatile metal and is everywhere. Lead is the most abundant of all heavy metals on the earth crust¹ Lead in workplace comes from emissions in the form of fine particles that are inhaled and absorbed through dermal exposure. Welders, carpenters and fuel station workers among other occupational groups are more prone to consequences of health hazard related to lead exposure.²³ Occupational exposure to lead occurs in lead smelting plants and battery factories as well as when workers inhale or ingest fumes and dust contaminated with lead. Occupational risk exists where lead and its compounds are present in the form of vapour or aerosol (lead fume, lead dust) in the working environment. Although United states of America (USA) and European union have banned lead as an additive to consumers fuel for road- going vehicles, lead continues to be used in developing countries, Nigeria included. Petrol station workers are constantly in contact with leaded gasoline during their daily activities.¹⁵

The world health organization (WHO) gave the annual number of non-fatal work related disease caused by exposure of hazards and dangerous conditions at the work place at 160 million of 2.8 billion global work forces.⁹

Lead poisoning is a major potential public health problem throughout the world particularly in developing countries, intoxication with lead accounted for 0.9% of the total global disease with 0.5 - 1.5 million being due to occupational exposure.¹

Lead has become widely dispersed throughout the environment because of the number of human uses in their daily life during activities such as welding, painting with leaded paint, battery manufacturing, construction work, stained-glass making, target shooting at firing ranges, plastic manufacturing etc.²²

Ramazzini described the dangers of poisoning from lead used by potters in their glaze. Hamilton investigated white lead employing careful and extensive use of hospital record to demonstrate the connection between specific illness and occupations and through investigation of factories learn which industrial process use dangerous chemicals.¹⁸

Lead toxicity affects the hematological, renal and neurological systems. Impaired respiratory function was observed in workers exposed to lead with elevated blood lead concentration and zinc protoporphyrin concentration.⁸ Severe lead poisoning causes significant residual damage to central nervous system (CNS), encephalopathy and delayed maturation. Adult with lead poisoning have increased incidence of depression, antisocial behaviour.¹⁸

Mercury in any form is poisonous with mercury toxicity most commonly affecting the neurologic, gastrointestinal and renal systems. Mercury poisoning can result from vapour inhalation, mercury ingestion, injection and absorption through the skin.³

Mercury occurs in three forms as: elemental, inorganic and

organic compounds. With the deadliest form as Methyl mercury having about 90% of it absorbed into the blood stream from the GIT upon ingestion and this can be obtained from consumption of fish from contaminated water where inorganic Hg had been converted to methyl mercury and other foods poisoned by mercury as a means of preservative. The fish eats contaminated vegetation and the inorganic Hg becomes biomagnified in the fish to organic Hg. Fish proteins binds more than 90% to the methyl mercury that no vigorous cooking means can remove it. Mercury toxicity is also thought to be an underlying cause of AUTISM in some children.¹⁹

Gasoline or petrol is a fuel, derived from petroleum crude oil used for spark-ignited internal combustion engines in automotive devices. Gasoline is a blended mixture of over 200 different hydrocarbon liquids ranging from those containing 4 carbon atoms to those of 11 or 12 carbon atoms. Gasoline and other end products are produced in petroleum refineries. Coal has an average of about 89microgram per kilogram ($\mu\text{g}/\text{kg}$) mercury (ppb w/w) with the most concern environmental mercury release.¹⁶ Until about late 1990s, petroleum products were seldom mentioned when research involving mercury emission were to be discussed. However, Crude oil averages about 4 micrograms per kilogram ($\mu\text{g}/\text{kg}$) mercury with about 5% of coal's content.¹³ Welding process involved the joining of pieces of metal by the use of heat, pressure or both. Majority of the heavy metals make up the component of the mixture of fine particles (fumes) and gas substances produced during welding activities of which mercury is one. And this can be very toxic when inhaled or by skin exposure.¹¹

For the purpose of this research work our focus was centered on the organic or methyl or nonessential heavy metals toxicity particularly as it affects petrol attendants and iron welders in some selected areas in Port Harcourt.

MATERIALS AND METHODS

This study was carried out in Obio/Akpor and Phalga, which are two of the Local Government Areas in Rivers State, Nigeria.¹² This study employed a cross-sectional approach. The study sample consisted of apparently 50 occupationally exposed subjects and 20 controls (apparently non occupational exposed subjects). The apparently occupationally exposed subjects, consisting 25 petrol-dispensing attendants in filling stations and 25 welders, volunteered to participate in this study. These occupations are among those likely to expose individuals to the compounds under review. Workers on part-time duties and those who spent less than six months on the job were excluded from this study. The age range of the subjects was between 15 to 40 years.

Ethical clearance was obtained from the Rivers State Hospitals Management Board, and informed consent was sort from the patients and only those who gave consent participated in the study. A structured questionnaire on demographic data was administered to all participants. Informed consent was sort from the patients and only those who gave consent participated in the study a structured questionnaire on demographic data was administered to all participants.

Blood Collection and Storage

Venous blood samples (5mls) were collected via venipuncture into labeled plain tubes certified for determination of metals in blood. The labeled tubes containing the blood samples were centrifuged at 3000rpm for 5minutes and serum was separated from the clotted blood for cadmium and mercury. Whole blood was used for lead analysis. The serum was then stored in the plain tubes (bottles) and placed in ice pack and transferred into a refrigerator at 4°C until analysis.⁶ To avoid external contamination of the blood sample, the skin at the site of the venipuncture was thoroughly cleaned with methylated spirit to remove any external traces of impurity that may have been present on the subject's skin.

Analysis of Blood Samples for Cadmium, lead and mercury Cadmium, lead and mercury were extracted from the blood samples using the conventional wet acid digestion met. The digested samples were subjected to elemental analyses using a calibrated solar thermo elemental AAS model SE-71906 flame atomic absorption spectrophotometer (Perkin-Elmer, HGA-2100). The Solar Thermo Elemental AAS Model SE-71906 was used in determining the content of heavy metals in the Acid digested samples.

STATISTICAL ANALYSIS

The data obtained were analyzed using graph pad prism version 5.03. Values are expressed as mean \pm standard deviation (SD). Student's *t* test was carried out and statistical significance was determined at $p < 0.05$.

RESULTS

In this study, the assessment of cadmium, lead and mercury toxicity on welders and petrol attendants were carried out. When the mean levels control (apparently healthy individuals and not occupationally exposed to cadmium, lead and Hg) were compared with petrol attendants, the result obtained shows the control had 0.15 ± 0.05 , 0.98 ± 0.09 and 0.001 ± 0.001 respectively while the petrol attendants were 0.33 ± 0.25 , 74.9 ± 3.33 and 0.012 ± 0.03 respectively (table 1,2). Similarly, the mean levels of control against the welders for cadmium, lead and mercury were same control as above and 0.27 ± 0.05 , 6.15 ± 4.38 and 0.013 ± 0.007 for welders

Parameter ($\mu\text{g}/\text{l}$)	Control	P. attendants	pvalue	t value	Remarks
Cadmium	0.15 ± 0.05	0.33 ± 0.25	0.0226	2.365	S
Lead	0.98 ± 0.94	7.49 ± 3.33	0.0001	8.463	S
Mercury	0.001 ± 0.001	0.012 ± 0.03	0.1194	1.589	NS

S = Significant; NS = Not significant

Table-1: Comparative analysis of control and petrol attendants

Parameter ($\mu\text{g/l}$)	Control	Welders	pvalue	tvalue	Remarks
Cadmium	0.15 \pm 0.05	0.27 \pm 0.05	0.0658	1.888	NS
Lead	0.98 \pm 0.94	6.14 \pm 4.38	0.0001	5.161	S
Mercury	0.001 \pm 0.001	0.013 \pm 0.007	0.0097	1.698	NS

S = Significant; NS = Not significant

Table-2: Comparative analysis of control and welders

Parameter ($\mu\text{g/l}$)	P. Attendants	Welders	pvalue	tvalue	Remarks
Cadmium	0.33 \pm 0.25	0.27 \pm 0.05	0.293	1.064	NS
Lead	7.49 \pm 3.33	6.14 \pm 4.38	0.2266	1.225	NS
Mercury	0.012 \pm 0.03	0.013 \pm 0.007	0.3188	1.007	NS

S = Significant; NS = Not significant

Table-3: Comparative analysis of petrol attendants and welders

respectively (table-3).

DISCUSSION

The result from this research showed that there is increase in blood cadmium level, which implies that exposure to petrol vapours was significantly high when compared to the control. An increase in this parameter may affect overall health of individual.⁵ These findings are in agreement with report by³ who reported degenerative change in organs functions after exposing to petrol vapour. It has also been observed by²³ that consumption of petroleum hydrocarbon-contaminated diets could cause organs enlargement, growth depression and histological changes. The observed increase in the level of cadmium in this study might lead to possible toxic effects on the membrane of the organs where petroleum hydrocarbons or carbon-containing compound may have been converted into free radicals or activated metabolite during their oxidation in the cells.²⁰ Exposure to petroleum and its products therefore constitute health hazards.

Similarly, mean lead level of petrol attendants and welders when compared to control showed significant higher ($p < 0.05$) increase in plasma lead level of welders and petrol attendants. The findings are in line with reports from previous studies by^{15,1} that lead is potentially toxic, its toxicity can cause aberrant function to multiple human organs. It inhibits many enzymes, including pyruvate dehydrogenase and enzymes of haem synthetic pathway. Because 90% of lead is bound to red blood cells, blood lead is the most reliable index.

From the tables, the mean levels of mercury of the control against petrol attendants as well as welders showed no significant difference. This agrees with, that long-term effect at $20\mu\text{g}/\text{m}^3$ (0.02ppm) vaporized mercury has subtle toxic effect on the central nervous system. This shows that during the refining process of petrol products greater percentage trace elements undergoes hydro-treatment stage, a process whereby Sulphur, nitrogen and metal contaminants, which includes mercury, are removed from middle distillates and catalytic cracker feeds. The result does not really imply the absence of this metal in the blood circulation of the petrol station attendant but the minute level could be because of the time frame of exposure to the vapour and the atmospheric temperature under which the service is carried out because mercury having a very high boiling point of 356.7°C as well

as releasing its vapour at that high temperature. But there is still a tendency that subtle behaviour of mercury vapour cannot be over emphasized.

Recommendation

Continuous inhalation and exposure to hydrocarbon and welding fumes without regular monitoring may have detrimental effect on human health. Therefore, public health measures should continue to be directed to the reduction and prevention of exposure of these compounds. Additionally, increase on emphasis on adequate nutrition, health care and attention to socioeconomic conditions that may worsen the effect of exposure of these compounds, welders using protective equipment's such as coverall and facemask to reduce exposure and proper policies by relevant authorities to be put in place.

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