Acta Scientific MEDICAL SCIENCES (ISSN: 2582-0931)

Volume 8 Issue 10 October 2024

Research Article

Effect of Petrochemicals to the Renal Electrolytes of Fuel Attendants (A Case Study of Oluyole Area in Ibadan, Nigeria)

Usiobeigbe OS[1]*, Adebanjo HA[2], Iyevhobu KO[3], Kehinde A[4], Airhomwanbor KO[1], Oweifa JT[5], Obohwemu KO[6], Bello GO[7], Asibor E[8] and Aliche PC[9]

[1]*Department of Chemical Pathology, Faculty of Medical Laboratory Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria*

[2]*Department of Medical Laboratory Science, Lead City University, Ibadan, Nigeria*

[3]*Department of Medical Microbiology, Faculty of Medical Laboratory Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria*

[4]*Faculty of Medical Laboratory Science, Achievers University, Owo, Ondo State, Nigeria*

[5]*Public Health Laboratory, Reference Hospital Akure, Ondo-State, Nigeria*

[6]*Department of Health, Wellbeing and Social Care, Global Banking School, London, United Kingdom*

[7]*Department of Nursing, Babcock University Ilisan Remo, Ogun State, Nigeria*

[8]*Department of Histopathology and Cytopathology, Faculty of Medical Laboratory Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria*

[9]*Department of Nursing Sciences, Clifford University, Owerrita, Abia State, Nigeria*

***Corresponding Author:** Usiobeigbe OS, Department of Chemical Pathology, Faculty of Medical Laboratory Science, Ambrose Alli University, Ekpoma, Edo State, Nigeria.

DOI: 10.31080/ASMS.2024.08.1924

Received: August 22, 2024

Published: September 12, 2024

Abstract

Petrochemicals are products derived from crude oil. These products contain a number of toxins that are considered to be dangerous to human health. Most of these chemicals when released can exhibit unfavorable effects in the air, water and soil pollution which comes in contact with humans and cause various problems such as renal damage. This study was undertaken to investigate the effects of petrochemicals in the kidney of fuel attendants in Ibadan metropolis of Oyo state, Nigeria.

Methods: This study is a cross sectional analytical study. Purposeful sampling method was applied to collect the data from the study populations. Investigations was carried out on 200 samples; 100 adult fuel attendants from different filling stations in Oluyole Area of Ibadan metropolis in Nigeria with 100 healthy adults as control. Kidney function tests were performed by evaluating the serum urea, creatinine, electrolytes (potassium, sodium, chloride and bicarbonate) levels of the subjects and control.

Results: The results revealed that serum Urea and Creatinine concentration was significantly higher ($p < 0.05$) in the tests subject when compared with the control. Also, the fuel attendants show significant ($p < 0.05$) increase in serum potassium, sodium and chloride ion concentrations compared with the control group.

Conclusion: This study is therefore suggestive of the fact that petrochemicals are environmental stressors. Thus, exposure to petroleum products e.g. gasoline, could possibly trigger biochemical reactions causing adverse effects on vital organs of the body particularly the kidney causing dysfunction and renal damage and prolonged exposure to these petroleum products over time could result to other effects.

Keywords: Petrochemicals; Petroleum; Gasoline; Fuel Attendants; Kidney Electrolytes

Abbreviations

ESKD: End Stage Kidney Disease; GFR: Glomerular Filtration Rate; JGA: Juxta-Glomerulo-Apparatus

Introduction

Petrochemicals are chemical products derived from crude oil [1]. Many of the same chemical compounds are also obtained from other fossil fuels such as coal and natural gas or from renewable sources such as corn, sugar cane, and other types of biomass [1]. The petrochemicals sector is a major segment of manufacturing industry as it has several connections with other sectors of an economy [2]. The petrochemical industry is responsible for manufacturing many of the things we use every day. Petrochemicals are useful in food industries, pharmaceutical industries, agricultural industries and technology industries [3]. These chemicals can be used in making fertilizers, polymers, solvents, dyes, pesticides, detergents, cosmetics, etc. These are exploited as fuel and lubricants for automotive and industrial purposes [1].

Petroleum distillates (petrochemicals) are any of a large group of chemicals derived from petroleum and natural gas either by direct manufacture or indirect manufacture as by-products which are used commercially [1]. Oil and natural gas are supposed to be the main sources for most petrochemicals because they are economical and readily accessible. Manufacturing of petrochemical products requires about 5% of the oil and gas each year. Petrochemicals share nearly 40 per cent of world chemicals market [2].

Petrochemical and petroleum products are the second-level products being derived from crude oil after several refining processes. Crude oil is the basic component to produce all petrochemical and petroleum components after a long process of refinement in oil refineries. The major hydrocarbon products produced from petroleum by refining are: liquefied petroleum gas, gasoline, diesel fuel, kerosene, fuel oil, lubricating oil, and paraffin wax (James, 2011).

Petrochemical products such as petrol, diesel, and other lubricants are in great demand in the market due to tremendous increase in number of vehicles [4]. Petrochemicals may be used as food grade lubricants in pharmaceutical; food processing plants is beverage industries [5].

The kidneys are vital organs that filter 180 litres of blood every 24 hours. Chemicals and toxins also get filtered through the kidneys. Exposure to chemical substances can cause adverse effects on the kidney, ureter, or bladder (Kidney Toxicity). The kidney is vulnerable because of its role in filtering the blood (Abdolghani., *et al*. 2016). Some chemicals and heavy metals cause severe injury to the kidney, while others produce chronic changes that can lead to kidney failure and cancer. In the workplace, the most common route of exposure to occupational renal disease is by inhalation (breathing a substance into the lungs), skin absorption, and swallowing [6].

Certain peoples have a greater risk of exposure to gasoline vapors; these include filling-station workers, service station attendants, drivers of gasoline trucks and refinery workers (Lewne., *et al*. 2016). The volatile nature of petrol products makes them readily available in the atmosphere any time it is dispensed, especially at petrol filling stations and depots (Periago & Prado, 2015). People are exposed to petroleum fumes during fueling and refueling at petrol stations, but the filling station workers are more at risk by virtue of their occupational exposure (Patrick-Iwuanyanwu., *et al*. 2011). Many of the harmful effects seen after exposure to petrol are due to the individual chemicals in the petroleum mixture, such as benzene, lead and oxygenates (Chabra., *et al*. 2011). Breathing small amounts of petroleum vapors can lead to nose and throat irritation, headaches, dizziness, nausea, vomiting, confusion and breathing difficulties. Some effects of skin contact with petroleum include rashes, redness, and swelling. Allergic reactions (hypersensitivity) have been reported but these are rare occurrences (Salvi., *et al*. 2012).

In Nigeria, more than 20 million people are living with kidney disease and no fewer than 20,000 of the number are coming down with End Stage Kidney Disease (ESKD) yearly requiring dialysis or/and transplant to stay alive, according to medical experts (Muanya, 2021). The increased use of petroleum products in automobiles and industry has led to the deterioration in air quality and human health. These products contain a number of toxins that are considered to be deleterious to humans (EPA, 2012). Although the petrochemicals give us innumerable useful products but they can also be injurious to the health of living beings and the earth's ecosystem (Miedema., *et al*. 2012).

Petroleum hydrocarbons and other related carbon containing compounds are converted into free radicals or activated metabolites during their oxidation in the cells, especially mammalian liver and kidney cells [7]. It is these activated metabolites that react with some cellular components such as membrane lipids to produce lipid peroxidation products which may lead to membrane change. They may also react with enzymes and cause inactivation through protein oxidation and/ or DNA strand breaks [3]. Exposure to petroleum and its products therefore constitute health hazards. These manifest as renal damage, nervous system damage, blood disorders (including anaemia, leukaemia), hepatic dysfunction and intoxication leading to serious psychotic problems, anaesthetic effects, dermatitis etc. [7]. Most of these chemicals when released can exhibit unfavorable effects on our environment such as air, water and soil pollution, which comes in contact with humans and cause various problems such as renal damage (Sucker., *et al*. 2018). Exposure to petrochemicals may take place in different ways; they may be absorbed through the skin or might be ingested. They can also affect human life by accumulating in tissues/organs and cause brain, nerve and renal damage and hormonal disorders. Skin-irritation, ulcers and allergic dermatitis are chronic effects of exposure [8].

The petrochemical industry is considered one of the major pollution sources of heavy metals, and the affected populations are limited not only to petrochemical workers but also to residents who live near the industry and are exposed to toxic heavy metals via the atmosphere or hydrologic cycle [9]. The aim of this study is to investigate the effect of petrochemicals in the kidney of fuel attendants in Oluyole Area of Ibadan metropolis of Oyo state, Nigeria.

Materials and Methods

Research design

This study is a community based cross-sectional analytical study designed to establish the effect of petrochemicals in the kidney of fuel attendants in Ibadan environs.

Population of study

The target population include fuel attendants sampled across Oluyole Area in Ibadan, Oyo State. The target number of respondents from the surveyed questionnaire is estimated to be 200 copies. However, to give room for loss of questionnaire or non-compliance, additional 10 copies (5%) was added, making a total of 210 questionnaires produced for sampling purpose.

Sampling techniques

Sampling included a list of characteristic important for eligibility in the target population. Sampling criteria included inclusion and exclusion sampling criteria. New garage, Soka, Sanyo, Ireakari, Oke-ado and Tollgate was selected as a typical target area, because fuel attendants are easily accessible there due to a large number of filling stations in those areas.

Sample size/study participants

The sample size for this study is 200. Of them, 100 were included as case group which were fuel attendants who work at the various filling stations visited in the Area. Their main direct sources of exposure were inhalation, accidental ingestion, and skin contact, among others. The control group, 100 people, did trade neither gasoline nor work in the oil industry.

The inclusion criteria were no past medical history of chronic diseases, including diabetes, hepatitis, renal failure, and blood disorders, no using a specific medicine, no smoker, and no alcohol consumptions. These samples were collected from people who are within the age range of 15-40 years.

Study variables

Demographic data, including gender, age, location, job duration (year) and working time (hour/day) were collected through a physical assessment.

Data collection techniques

This case-control study was conducted in Oluyole local government area, Ibadan between April and May 2022. All the selected communities in the Area that is to participate in the study were visited by the researchers. A purposeful sampling method was applied to collect the data from the study populations. Questionnaires were filled and duly signed by all the participants prior to data collection.

Description of research instrument

This case-control study involves the use of both qualitative and quantitative research techniques. For the qualitative research, questionnaire was distributed to all the participants and were filled with proper guidance. For the quantitative research, instrument like reagents, spectrophotometer, centrifuge, weighing balance and sample bottles was used.

Validity and reliability of research instrument

For the qualitative research, the validity and reliability of the questionnaire was taken into consideration, taking guidance from the language and clinical subject expertise. The questionnaire was written at a sixth-grade level of reading. For the quantitative research, the instrument (spectrophotometer) to be used has been calibrated by the manufacturer. Also, a pilot study was carried out to validate this experiment.

Ethical approval

The ethical approval was obtained from the Ethics Committee at Lead City University, Ibadan. The purpose of the study was explained to the participants and an oral and written consent was achieved before data and sample collection.

Sample analysis

Five ml venous blood was taken for the laboratory tests in the mornings, and the levels of following parameters were tested after spinning and separation of the samples (Urea (U), Serum creatinine (Cr), Sodium (Na), Potassium (K), Chloride (Cl) and Bicarbonate (HCO_3).

Urea

Test principle (urease-berthelot method – colorimetric)

Urea is hydrolysed in the presence of water and urease to produce ammonia and carbon dioxide. Ammonium ions react with hypochlorite and salicylate to form a green dye. The increase in absorbance at 578nm is proportional to the urea concentration in the sample (Henry, 1963).

Calculation

Urea conc. (mg/dL) = <u>Absorbance of Sample</u> x 40

Absorbance of Standard

Reference range

Serum/Plasma Urea = 10-55 mg/dl [10].

Creatinine

- **Principle:** Creatinine reacts with alkaline picrate reagent to form an orange-red colour which is measured in a spectrophotometer (Searcy., *et al*. 1967).
- **Calculation:** $\frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times \text{conc. of standard}$
- **Reference Values:** Serum/Plasma Creatinine 0.5-1.65 mg/dl [10].

Sodium

Principle

Sodium is estimated by colorimetric method based on modified Maruna and Trinders method. Sodium and proteins are precipitated together by Magnesium uranyl acetate as Uranyl magnesium sodium acetate salt. Excess of uranyl salt reacts with potassium ferrocyanide to produce a brownish colour. The intensity of the colour is inversely proportional to the sodium concentration in the specimen and is measured photometrically at 530nm (500-546nm) (Trinder, 1951; Tietz, 1976).

Uranyl ions + Mg ion + Na^+ → Uranyl Mg Na Precipitate

Free Uranyl ions + $k_2Fe(CN)_6$ → Brown-coloured Complex

Calculation

Sodium Concentration (mMol/L) =

<u>Absorbance of Blank – Absorbance of Sample</u> x 150

Absorbance of Blank – Absorbance of Standard

Reference range

Serum/Plasma: 135-145mMol/L (Tietz, 1976).

Potassium

Principle

The amount of potassium is determined by using sodium tetraphenylboron in a specifically prepared mixture to produce a colloidal suspension. The turbidity of which is proportional to potassium concentration in the range of 2-7mEq/L (Tietz, 1976).

Calculation

Potassium Conc. (mMol/L) =

<u>Absorbance of unknown</u> x Conc. Of Standard (mMol/L)

Absorbance of Standard

Expected values

3.5 – 5.5 mMol/L (Tietz, 1976).

Chloride

Principle

Chloride ions form a soluble, non-ionized compound, with mercuric ions and will displace thiocyanate ions from non-ionized mercuric thiocyanate. The released thiocyanate ions react with ferric ions to form a colour complex that absorb light at 480nm. The intensity of the colour produced is directly proportional to the chloride concentration (Henry., *et al*. 1974).

$Hg\ (SCN)_2 + 2Cl \rightarrow HgCl_2 + 2SCN$

$3SCN + Fe^{3+} \rightarrow 4Fe\ (SCN)_3$ red complex

Calculations

Concentration of chloride (mEq/L) =

Absorbance of unknown x Conc. Of Calibrator

Absorbance of Calibrator

Expected values

Serum: 96 – 106mEq/L (Tietz, 1976).

Bicarbonate

Principle

The reagent used is based upon phosphoenolpyruvate carboxylase (PEPC) utilizing bicarbonate present in the sample to produce oxaloacetate and phosphate. Malate dehydrogenase (MDH) then catalyzes the reduction of oxaloacetate to malate and the oxidation of NADH to NAD^+. The resulting decrease in absorbance can be measured at 380nm and is proportional to the amount of bicarbonate present in the sample (Henry, 1974; Tietz, 1976).

Calculation

Bicarbonate = Absorbance of Test x 25(mmol/L)

Absorbance of Standard

Normal values

21 – 31 mmol/L (Tietz, 1976).

Data/statistical analysis

The data obtained were entered in a spreadsheet and analyzed using the Statistical Package for the Social Sciences (SPSS) version 21. The odds ratio for the study parameters were calculated. The correlation was assessed using Pearson's correlation coefficient. The p-values were set at 0.05 of the confidence interval at 95% and 0.01 of the confidence interval at 99%.

Results and Discussion

Results represented as Mean ± SEM. n (control) = 100, n (subject) = 100.

P value of Urea in the fuel attendants is < 0.05 when compared with the control group (SEM = 53.52 ± 6.85). Urea in the fuel attendants was significantly increased by 92.5% when compared with the control.

P value of creatinine in the fuel attendants is < 0.01 when compared with the control group (SEM = 1.97 ± 0.45). From the figure, Creatinine in the fuel attendants was significantly increased by 117% when compared with the control.

P value of Sodium in the fuel attendants is < 0.05 when compared with the control group (SEM = 144.26 ± 3.67). From the figure, Sodium in the fuel attendants was significantly increased by 51.7% compared with the control.

P value of Potassium in the fuel attendants is < 0.05 when compared with the control group (SEM = 5.48 ± 0.76). From the figure, Potassium in the fuel attendants was significantly increased by 70.6% when compared with the control.

P value of Chloride in the fuel attendants is < 0.05 when compared with the control group (SEM = 105.53 ± 3.97). From the figure, Chloride in the fuel attendants was significantly increased by 52.6% when compared with the control.

From the figure, Bicarbonate in the fuel attendants was insignificantly (P > 0.05) increased when compared with the control group (SEM = 28.73 ± 5.59).

	Sample	Mean	Std. Deviation	Std. Error Mean	T	Prob.
Urea	Non-Fuel Attendant	28.9200	6.96119	.69612	-25.186	.000
	Fuel Attendants	53.5200	6.85120	.68512		
Creatinine	Non-Fuel Attendant	.8410	.24083	.02408	-22.206	.000
	Fuel Attendants	1.9680	.44673	.04467		
Sodium	Non-Fuel Attendant	139.4000	2.78161	.27816	-10.559	.000
	Fuel Attendants	144.2600	3.66700	.36670		
Potassium	Non-Fuel Attendant	3.8770	.27592	.02759	-19.809	.000
	Fuel Attendants	5.4780	.75966	.07597		
Chloride	Non-Fuel Attendant	100.1600	2.71070	.27107	-11.165	.000
	Fuel Attendants	105.5300	3.97328	.39733		
Bicarbonate	Non-Fuel Attendant	29.2400	3.76888	.37689	.756	.450
	Fuel Attendants	28.7300	5.59194	.55919		

Table 1: Urea, Creatinine, Potassium, Sodium, Chloride and Bicarbonate In Fuel Attendants and Non-Fuel Attendants in Ibadan environs.

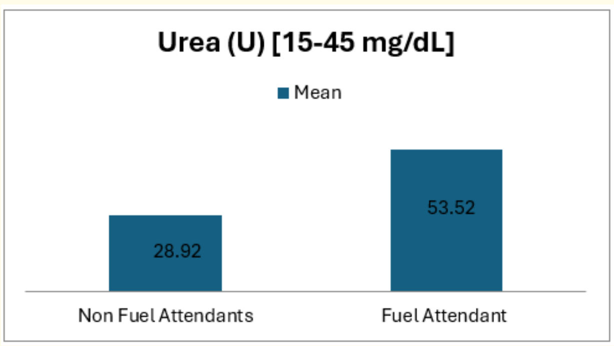

Figure 1: Urea levels of non-fuel attendants and fuel attendants in the Ibadan area.

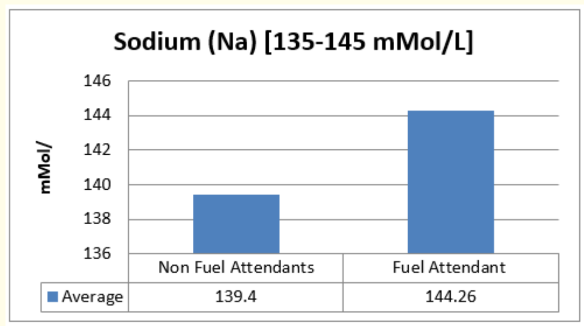

Figure 3: Sodium levels of non-fuel attendants and fuel attendants in Ibadan environs.

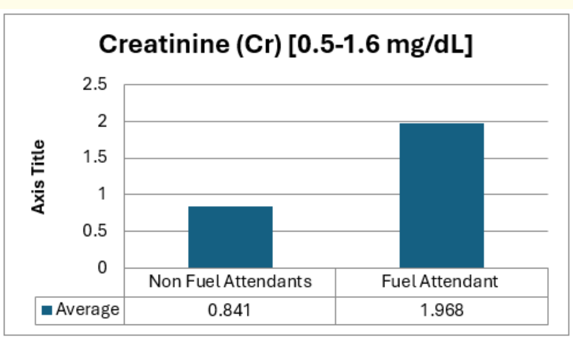

Figure 2: Creatinine levels of non-fuel attendants and fuel attendants in Ibadan environs.

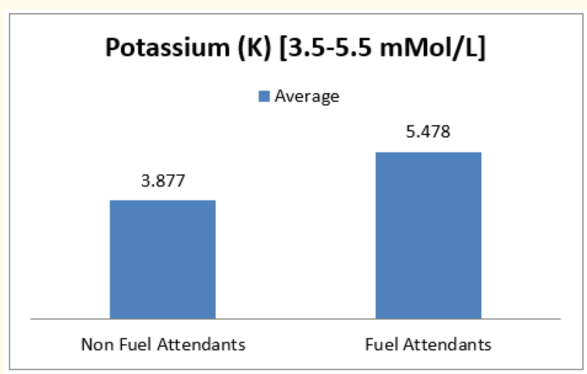

Figure 4: Potassium levels of non-fuel attendants and fuel attendants in Ibadan environs.

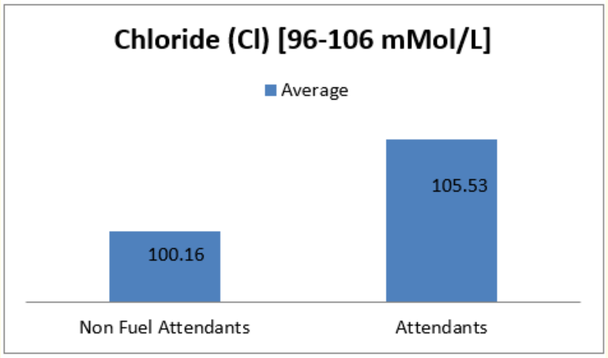

Figure 5: Chloride levels of non-fuel attendants and fuel attendants in Ibadan environs.

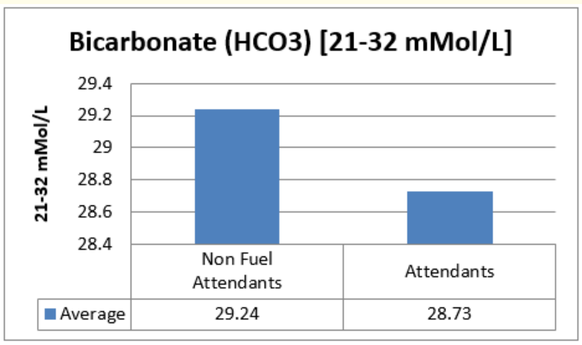

Figure 6: Bicarbonate levels of non-fuel attendants and fuel attendants in Ibadan environs.

Exposure to petrochemicals e.g. gasoline causes a wide variety of adverse effects which could be acute or chronic and may be fatal; gasoline has the ability to cause renal toxicity and renal damage following a prolong exposure [9]. The aim of this study was to assess the effect of petroleum products on the kidney functions among fuel attendants in Ibadan environs. Unintentional ingestion/inhalation and dermal exposure or oral ingestion in a suicide attempt are all examples of gasoline exposure routes [11]. In the present work, each case under study was interviewed with a detailed questionnaire and kidney function tests were performed.

This study showed a significant difference between the subject and the control group as regard the urea level. The mean value of urea level of the subject group is (53.52 ± 6.85) and is significantly elevated ($P < 0.05$) with percentage of 92.5%. This result is in harmony with the work of Ogunneye., *et al*. [7] who found urea to be elevated significantly among exposed subjects to a unique petrochemical. Furthermore, Awadalla., *et al*. [6] and Ekpenyong & Inyang [12] in their studies, where there was significant difference between the exposed group and unexposed groups as regard urea level. This elevation in urea levels may be due to a fall in glomerular filtration rate (GFR) as a result of exposure to petroleum products and this elevation may be attributable to damage of the structural integrity of the nephrons.

The mean value of creatinine level for the studied group was (1.97 ± 0.45). There was significant difference ($p < 0.01$) in plasma creatinine level of the fuel attendants when compared with the control group and percentage of 117%. This is in agreement with the work of Bin-Mefrij and Alwakeel [11], who in their study, reported that there was a difference statistically between the studied group and the control group as regard creatinine level. Also, Ogunneye., *et al*. [7], submitted that, there was significant elevation of creatinine level in the studied subject as compared with their control group in albino wistar rats fed with petrochemicals. However, this result is in contrast with Elnabi., *et al*. [9] who stated in their study that there was no significant difference as regard creatinine level between the studied group and control group.

Regarding the effect of petroleum fumes on some selected plasma electrolytes of the fuel attendants, the subjects show a significant ($P < 0.05$) increase in plasma potassium ion concentration compared with the control subjects with a mean value of 5.48 ± 0.76 with percentage of 70.6%. The subjects also show significant ($P < 0.05$) increase in sodium and chloride ions concentrations compared with the control subjects with the mean values of 144.26 ± 3.67 and 105.53 ± 3.97 respectively, and with percentage of 51.7% and 52.6%. These results were also in accordance with the research work conducted by Ogunneye., *et al*. [7] in which their studies shows a significance difference in the selected plasma electrolytes (Potassium, sodium and chloride ions) of the studied group and the control group.

However, the plasma bicarbonate concentration has no significant ($p > 0.05$) increase in the subjects when compared with the control with the mean value of 28.73 ± 5.59. Serum/plasma bicarbonate estimation helps to identify or monitor an electrolyte imbalance or acid-base (pH) imbalance. Raising and lowering the respiratory rate alters the amount of CO_2 that is breathed out, and this can affect blood pH within minutes [13]. However, a bicarbonate level that is higher or lower than normal may mean that the body is having trouble maintaining its acid-base balance, either by failing to remove carbon dioxide through the lungs or the kidneys or because of an electrolyte imbalance, particularly a deficiency of potassium [14].

Some studies have reported significant association between exposure to gasoline and changes in serum electrolyte, urea and Creatinine levels. Whereas, others have found non-significant effect between exposure and serum levels of these substances, these nephrotoxic effects of gasoline constituents a controversial scientific issue [9]. Induction of oxidative stress, immune system dysfunction, and inflammation have been implicated in the pathogenesis of gasoline-induced renal function impairment [12,15].

Petroleum hydrocarbons and other related carbon-containing compounds are converted into free radicals or activated metabolites during their oxidation in cell especially mammalian liver and kidney cells. These activated metabolites react with some cellular component such as membrane lipid to produce peroxidation products which leads to distortion of membrane integrity. They may react with enzymes and cause inactivation through protein oxidation and or DNA damage of the strands at positions 4, 5 and 8 of the purines and pyrimidine bases.

Furthermore, the effects of the radicals on the mitochondria which is the power house of the cell will unequivocally result to disruption of the electron transport chain which is necessary for oxidation and reduction (Abdelrahman., *et al*. 2016).

Following exposure, gasoline is bio-transformed into reactive metabolites which can directly impair renal function by binding covalently to renal macromolecules and leading to altered structure and biochemical function including impaired activities of some enzymes involved in homeostatic mechanisms. For example the disruption of the nephrons could result in anemia because the erythropoietin responsible for erythropoiesis (RBC formation) is a product of juxta-glomerulo-apparatus (JGA) around the proximal convoluted tubules of the nephrons [12].

Conclusions

It can be concluded from this study that exposure to petroleum fumes and chemicals may be associated with significant increase in urea, creatinine potassium sodium and chloride levels, and no significant increase in bicarbonate level among workers in fuel stations (fuel attendants). Results generated from this study is therefore suggestive of the fact that petrochemicals are environmental stressors. Thus, exposure to petroleum products e.g. gasoline, could possibly cause adverse effects on vital organs in the body particularly the kidney causing kidney dysfunction, and also renal damage or renal cell cancer over time following prolonged exposure to these petroleum products.

Based on the fact that exposure to petrol fumes could have adverse effects on the kidney and some other vital organs in the body. Therefore, this study recommends that there is need to modify the mode of operation of the fuel attendants so as to safeguard their health and this can be achieved by adopting the use of personal protective equipment such as nose masks, face shield, wearing of protective wears, etc. Although this cannot completely stop the exposure to the petroleum fumes but can reduce it to some certain level and could minimize the hazards of exposure to petroleum products.

It is also recommended to assess the medical status of workers before joining the jobs to check their fitness then periodic medical checkup to determine if the workers have probability to develop chronic renal disease. This include regular monitoring, investigations and follow up for workers which should be done with improved working conditions and also using natural gas for cars as an alternative to gasoline.

Study Limitations

Study participants willingness to participate in the study.

Getting approval from the hospital and also reagent supply was a bit slow and delayed.

Conflict of Interest

The authors declare no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' Contributions

The entire study procedure was conducted with the involvement of all authors.

Acknowledgements

The authors would like to acknowledge the management of Lead City University, Ibadan, Oyo State, Nigeria for creating the enabling environment for this study. Thanks to all the technical staff of St Kenny Research Consult, Ekpoma, Edo State, Nigeria for their excellent assistance and for providing medical writing/editorial support in accordance with Good Publication Practice (GPP3) guidelines.

Bibliography

1. Speight, J. G. (2017). The Chemistry and Technology of Petroleum. (4th edn), CRC Press, Taylor and Francis Group, Boca Raton, Florida, USA.
2. Sharma, S. K., Dhakal, S., & Thapa, L. (2017). Community-based screening for chronic kidney disease, hypertension and diabetes in Dharan. J Nepal Med Assoc., 52, 205-214.
3. Divya, B. T., Alpa, Y., Anuradha, M. (2017). Applications of Petrochemicals: A Mini Review. Recent Advances in Petrochemical Science, 2, 917 –927.
4. Wenpo, R., Chaoh, Y., & Honghong, S. (2012). Characterization of average molecular structure of heavy oil fractions by 1H nuclear magnetic resonance and X-ray diffraction, China. Petroleum Processing and Petrochemical Technology, 26 (2), 82e92.
5. Firouzkouhi, M., Abdollahimohammad, A., & Babaiepur-Diveshali, M. (2016). Effects of gasoline on blood, kidney and liver parameters of unregulated gasoline traders. Der Pharm Lett., 8, 58–61.
6. Awadalla, A. H., Ahmed, N. A., & Yagoob, A. Y. (2017). The effects of Petroleum Products on Renal Function among Petroleum Filling Workers Stations in EL-Obied City. European Journal of Pharmaceutical and Medical Research (ejpmr), 4(10), 395-399.
7. Kuburi, L. S., Umar, U., & Oyedeji, A. N. (2023). Risk Assessment of Petrol Filling Stations in a Metropolitical City of Kaduna State, Nigeria. SINERGI, 27(2), 179-184.
8. Song, C., Liu, Y., Sun, L., Zhang, Q., & Mao, H. (2020). Emissions of volatile organic compounds (VOCs) from gasoline-and liquified natural gas (LNG)-fueled vehicles in tunnel studies. Atmospheric Environment, 234, 117626.
9. Mohsin, M., Yin, H., Huang, W., Zhang, S., Zhang, L., & Mehak, A. (2022). Evaluation of occupational health risk management and performance in China: A case study of gas station workers. International Journal of Environmental Research and Public Health, 19(7), 3762.
10. Kuppusamy, S., Maddela, N. R., Megharaj, M., Venkateswarlu, K., Kuppusamy, S., Maddela, N. R., ... & Venkateswarlu, K. (2020). Impact of total petroleum hydrocarbons on human health. Total petroleum hydrocarbons: Environmental fate, toxicity, and remediation, 139-165.
11. Park, J. H., Park, H. C., Kim, D. H., Lee, Y. K., & Cho, A. (2023). Mortality and Risk Factors in Very Elderly Patients Who Start Hemodialysis: Korean Renal Data System, 2016–2020. American Journal of Nephrology, 54(5-6), 175-183.
12. El-Sayed, R. A., Jebur, A. B., Kang, W., & El-Demerdash, F. M. (2022). An overview on the major mycotoxins in food products: Characteristics, toxicity, and analysis. Journal of Future Foods, 2(2), 91-102.
13. Demiralay, E. C., & Yilmaz, H. (2023). Applications of Petrochemistry in Biomedicine. Processes of Petrochemistry and Oil Refining, 24(4).
14. Ogunneye, A., Omoboyowa, D., Sonibare, A., Adebusuyi, A., & Faniran, T. (2014). Hepatotoxic and nephrotoxic effects of petroleum fumes on petrol attendants in Ibadan, Nigeria. Niger J Basic Appl Sci., 22, 57–62.
15. Ukaogo, P. O., Ewuzie, U., & Onwuka, C. V. (2020). Environmental pollution: causes, effects, and the remedies. In Microorganisms for sustainable environment and health (pp. 419-429). Elsevier.
16. Axelsson, G., Barregard, L., Sallsten, G., & Holmberg, E. (2012). Cancer incidence in a petrochemical industry area in Sweden. Sci Total Environ., 3(1), 39-44.
17. Elnabi, T.-H., Yuan, M. J., Jhuang, Y.P. & Yeh, H. (2021). Relationship between renal function and metal exposure of residents living near the No. 6 Naphtha Cracking Complex: A cross-sectional study. Journal of the Formosan Medical Association, 7, 195- 201.
18. Burtis, C. A., Ashwood, E. R., & Bruns, D. E., (2011). Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. eds. 5th edition, St. Louis: Elsevier Saunders
19. Bin-Mefrij, M., & Alwakeel, S. (2017): The effect of fuel inhalation on the kidney and liver function and blood indices in gasoline station workers. Advances in Natural and Applied Sciences, 11(1), 45-50.
20. Ekpenyong, C. & Inyang, M. (2017): A CrossSectional Survey of Estimated Glomerular Filtration Rate, Acid-Base Balance and Electrolyte Status among Workers Exposed to Petroleum Products. J Nephrol Kidney Dis., 1(2), 1008.
21. Dugdale, D. (2013). CO2 blood test. MedlinePlus Medical Encyclopedia [On-line information]. Available online at http://www.nlm.nih.gov/medlineplus/ency/article/003469.htm. Accessed 10/15/22.
22. Byrd, R. & Roy, T. (2015). Respiratory Acidosis. Medscape Drugs & Diseases [On-line information]. Available online at http://emedicine.medscape.com/article/301574-overview. Accessed 10/15/22.
23. Azeez, O., Akhighe, R., & Anigbogu, C. (2013): Oxidative stress in rat kidney exposed to petroleum hydrocarbon. J. Nat Sci Med., 4, 149-154.