Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 123-132
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

EFFECT OF GASOLINE EXPOSURE ON SOME RENAL AND HEPATIC FUNCTION PARAMETERS OF PETROL STATION WORKERS IN PORT HARCOURT METROPOLIS, NIGERIA.

[1]Orolua, C.C., [2]Monago-Ighorodje, C.C.,[3]Ogbonnaya, E.A., and [4]Ezendiokwere, O.E.
[1,2,3,4]Department of Biochemistry, Faculty of Science, University of Port Harcourt, P.M.B 5323, Port Harcourt, Nigeria.
Corresponding author Email: oroluachoice@gmail.com; ezeonyebuchiredeemed@gmail.com
Tel: +234 8104016399.

Received: 01-11-2024
Accepted: 03-12-2024

https://dx.doi.org/10.4314/sa.v23i5.10

Journal Homepage: http://www.scientia-african.uniportjournal.info
Publisher: *Faculty of Science, University of Port Harcourt.*

ABSTRACT

This research was to investigate the effect of gasoline exposure on the liver and kidney function biomarkers of petroleum attendants in Port Harcourt metropolis, Rivers State, Nigeria. A total of 60 subjects participated in the study, comprising 20 unexposed individuals and 40 exposed to gasoline. Socio-demographic characteristics and duration of exposure data were obtained using a structured questionnaire. According to age group and duration of exposure, the participants were grouped accordingly. Biochemical markers of liver and kidney functions were carried out using standard methods. The mean creatinine level and urea concentrations for subjects with duration of exposure for 3-5 years and > 5 years (71.43 ± 3.89 mmol/L and 3.03 ± 0.24 mmol/L) and (69.38 ± 2.40mmol/L and 2.81 ± 0.09mmol/L) respectively were significantly elevated in comparison to the unexposed group. Elevated levels of AST and GGT (34.00 ± 9.10 U/L and 95.14 ± 52.21 U/L) respectively were witnessed in the long-term exposure group. This differed significantly when compared to the unexposed control group. The creatinine, urea and AST levels (71.67±2.41mmol/L, 2.87±0.18mmol/L and 33.50±5.09IU/l) respectively for the age bracket 36-45 years when compared to the age bracket 18-25 years (60.00±1.74mmol/L, 2.49±0.09mmol/L and 28.25±2.46IU/l respectively) showed a significant increase (P< 0.05).A relationship exists between levels of liver function parameters and kidney function markers and the duration of gasoline exposure. Vapour adversely imparts health and has a deleterious effect on liver and kidney function. Hence older petroleum workers could be considered more prone to organ stress.

Keywords: Petroleum Attendants, Gasoline Exposure, Health Impacts, Biochemical Markers, Organ Function, Port Harcourt Metropolis.

INTRODUCTION

Occupational exposure to gasoline has raised significant health concerns, particularly regarding its impact on renal and liver function. Essential organs may be negatively impacted by the hazardous substances found in gasoline, which is a complex combination of

hydrocarbons that includes benzene, toluene, and xylene (Ekpenyong & Asuquo, 2017). Employees at gas stations may come into contact with Gasoline from eating, skin contact, or inhalation, among other means (Gunathilaka et al., 2017). Chronic inhalation of gasoline fumes can cause a variety of health issues, including liver and kidney function damage (Gunathilaka et al., 2017). As gasoline fumes can be inhaled when handling Gasoline or working in locations where gasoline is stored or used, inhalation is a frequent exposure method. Several studies have reported the health impact of gasoline including its carcinogenicity. Many of these effects have also been attributed to its composite compounds which are mostly volatile (Jasper et al., 2016; Folabi & Phan, 2020; Al Madhoun et al., 2008). Benzene is primarily metabolized to phenol by the cytochromeP450 system of the liver. It has also been reported that liver enzymes are involved in the dentoxification. It has also been reported that the liver enzymes are involved in the detoxification of toxicants including the substances present in gasoline (Kim et al., 2004; Sun et al., 2014).Hence, abnormalities in the levels and regulation of these enzymes may indicate liver injury or disease. When the liver is injured these enzymes can seep into systemic circulation and blood tests can easily identify their levels. Notable among these enzymes are alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) and gamma-glutamyl transferase (GGT) which are indicators of liver health and function (Kunutsor et al., 2014). Heavy metals such as cadmium and lead are reportedly present in gasoline, hence exposure to gasoline impacts negatively on the kidney. Elevated levels of creatinine and blood urea nitrogen are commonly associated with gasoline and its components (Neghab et al., 2015; Jaishankar et al., 2014). Studies have also revealed that chronic exposure to gasoline fumes may result in chronic organ damage. There have been reports stating that the severity of damage may escalate over time if not controlled, contributing to a range of health issues (Harper & Liccione, 1995). This study seeks to clarify the potential renal and hepatic dysfunctions associated with gasoline exposure.

MATERIALS AND METHODS

Ethical Approval

Ethical clearance for this research was obtained from the Research Ethics Committee of the University of Port Harcourt, Nigeria to ensure compliance with ethical standards and guidelines for human research. Questionnaires on work and health condition were shared with these pump attendants across the visited stations. This was followed by providing a written consent form that recapitulated key aspects of the study, such as the purpose, procedures involved, potential risks and benefits, confidentiality measures, and contact information for queries or concerns.

Study Area and Design

A cross-sectional case-control study involving two separate populations within Port Harcourt Metropolis, Nigeria. A total of 60 volunteers, who were between the ages of 18 to 45 years were recruited for this study. 40 were gasoline exposed pump attendants from ten different gasoline station in Port Harcourt who have been exposed for at least 8 hours daily over a year and above. On the other hand, the control group comprised 20 apparently healthy individuals, mostly students from the University of Port Harcourt. Dependent variables included health indicators, biochemical markers also self-reported symptoms (e.g., headaches, nausea, irritation and itches). Bio data, working conditions, medical history, Period of exposure, physical examination reports and consent approval were also obtained from all participants. A statistical analysis was conducted to compare the values of the dependent variables between the experimental and control groups. The

Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 123-132
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

study population did not include subjects who were smokers, aged below 18 or above 45 years, pregnant, on special medications, or had a history of health complications. The control group had no history of occupational exposure to gasoline vapors or other similar chemicals.

Data and Sample Collection

Blood specimens were meticulously collected from study participants by venipuncture to ensure accuracy and the preservation of sample integrity. Using a ten (5) ml syringe and 21G needle, blood was drawn from participants by venipuncture. The drawn blood samples were collected in a Lithium Heparin sample bottle for biochemical analysis. These bottles were appropriately labelled and conveyed immediately to the University of Port Harcourt Teaching Hospital where they were separated with a centrifuge (800; Avalon Health, England) and analyzed at the Department of Chemical Pathology, University of Port Harcourt Teaching Hospital, Choba, Rivers State, Nigeria. Samples were centrifuged for 5 minutes at 1000 rpm. The serum was separated from the cells and transferred into a Bijou (sample) bottle at 20^0C in a deep freezer until time for analysis which was within thirty days of collection.

Analysis of Electrolyte Levels

The estimation of Sodium ion, Potassium ion and Chloride ion Concentration (Na^+, K^+&Cl^-) in plasma was performed using an Ion-selective electrode (Fogh-Andersen et al., 1984).While the back-titration method was employed to determine the level of bicarbonate in the plasma (Pauss et al., 1990).

Determination of Urea Concentration

Diacetyl-monoxime Method (D.A.M.) was employed for the determination of urea concentration in plasma (Langenfeld et al., 2021).

Determination of Creatinine Levels

The Jaffe method as described by Delanghe and Speeckaert was adopted for this test (Delanghe & Speeckaert, 2011). The preparation of the alkaline picrate solution involved dissolving picric acid in a sodium hydroxide solution to achieve a final concentration of approximately 0.5 to 1.0% picric acid in a 0.1 N NaOH solution. In a clean cuvette or test tube, 0.1 mL of the serum or plasma sample was added. Next, 2 ml of the alkaline picrate solution was added to the sample in the cuvette test tube, and the mixture was thoroughly mixed by gently swirling the cuvette tube to ensure complete mixing of the reagents. After the incubation period, the absorbance of the reaction mixture is measured at a wavelength of 520 nm using the spectrophotometer. A blank containing only the alkaline picrate solution was also measured for baseline correction. To determine the concentration of creatinine in each sample, the absorbance reading of the sample was compared to the standard curve prepared using known concentrations of creatinine.

Determination of Enzyme Activity (AST, ALT, ALP & GGT).

The activity of Aspartate aminotransferase (AST), Alanine aminotransferase (ALT), and Alkaline phosphatase (ALP) was determined using spectrophotometric methods (Rej & Shaw, 1984).To determine the activity of Gamma-glutamyltransferase, the method described by Gjerde & Morland (Gjerde & Mørland, 1985) was adopted.

Data Analysis and Interpretation

The raw data collated by the present study was analyzed using Statistical Package for Social Science (SPSS) (version 23 for Windows 11, SPSS Inc., Chicago, USA).

To compare the biochemical parameters between gasoline-exposed participants and the control group, independent samples t-tests

were conducted. Additionally, one-way ANOVA was used to assess differences in these parameters among different duration of exposure categories (non-exposed, 1-2 years, 3-5 years, above 5 years) and age groups (18-25 years, 26-35 years, 36-45 years). All statistical tests were two-tailed, and a p-value of <0.05 was considered statistically significant. Results were presented as mean ± standard error (SE).

RESULTS

Effect of Gasoline Exposure on Electrolyte Concentrations across Different Exposure Durations.

Table 1 shows the effect of exposure to gasoline on the electrolyte level of both control and exposed categories. In comparison to the non-exposed group, there was a statistically significant difference in the levels of K^+(mmol/L), HCO_3^-(mmol/L), and Cl^-(mmol/L) when compared to the exposed group. For comparison of the levels ofK^+ for the non-exposed versus exposed groups, there was statistically significant variation (3.41±0.08mmol/L versus 3.67±0.09mmol/L, 3.86± 0.18mmol/L, 3.70 ±0.09mmol/L). Comparison across exposure duration reveals a variation which is not statistically significant (p>0.05).

Effect of Gasoline Exposure on Liver and Kidney Function Markers across Different Exposure Durations.

Study participants in the non-exposed group showed elevated levels of creatinine, urea, AST, ALT and ALP (61.70 ± 1.44mmol/L, 2.75 ± 0.43mmol/L, 19.30 ± 2.14IU/L, 20.75±2.42 IU/L and 54.85±4.51 IU/L) when compared to the exposed groups (63.40±1.44mmol/L,69.38±2.40mmol/L, 71.43±3.89mmol/L; 2.56±0.59mmol/L, 3.03±0.24mmol/L, 2.81±0.09mmol/L; 25.56±1.85IU/L, 21.88±3.82IU/L, 34.00±9.10IU/L; 22.16±1.48IU/L, 22.00±3.35IU/L, 29.57±7.99IU/L and 71.64±8.81IU/L, 63.75±12.21IU/L, 73.00±18.31IU/L).

The level of GGT of the non-exposed group showed a significant decrease (p<0.05) was compared to the short-term and medium-term exposure groups.

Table 1. Comparison of Electrolyte Levels among Exposed and Control Study Participants in Port Harcourt Metropolis, Nigeria.

Period of Exposure	Na^+(mmol/L)	K^+(mmol/L)	HCO_3^-(mmol/L)	Cl^-(mmol/L)
Control	137.45±0.53[a]	3.41±0.08[a]	23.90±0.44[a]	101.65±0.70[a]
1-2 year(s)	137.56±1.01[a]	3.67±0.09[b]	25.32±0.29[b]	100.60±0.63[a]
3-5years	138.00±1.66[a]	3.86±0.18[b]	25.00±0.54[b]	102.00±1.21[b]
>5 years	138.71±1.15[a]	3.70±0.09[b]	24.57±0.20[b]	102.43±1.25[b]

Values represent the Mean ± Standard Error of the Mean of the sample. (n= 60). Means in the same column with different superscript alphabets are significantly different at p<0.05.

Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 123-132
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

Table 2. Comparison of Concentrations of Liver and Kidney Function Markers among Exposed and Non-exposed Study Participants in Port Harcourt Metropolis, Nigeria.

Group	Creatinine (mmol/L)	Urea (mmol/L)	AST (IU/L)	ALT (IU/L)	ALP (IU/L)	GGT (IU/L)
Non-Exposed (Control)	61.70±1.44^{b}	2.75±0.43^{b}	19.30±2.14^{a}	20.75±2.42^{a}	54.85±4.51^{a}	37.20±3.76^{a}
1-2 year(s)	63.40±1.44^{b}	2.56±0.59^{b}	25.56±1.85^{b}	22.16±1.48^{a}	71.64±8.81^{b}	31.80±5.23^{a}
3-5 years	69.38±2.40^{a}	3.03±0.24^{a}	21.88±3.82^{a,b}	22.00±3.35^{a}	63.75±12.21^{a,b}	33.38±6.37^{a,c}
>5 years	71.43±3.89^{a}	2.81±0.09^{a,b}	34.00±9.10^{b}	29.57±7.99^{a}	73.00±18.31^{b}	95.14±52.21^{b}

Values represent the Mean ± Standard Error of the Mean of the sample. (n= 60). Means in the same column with different superscript alphabets are significantly different at $p<0.05$.

Effect of Gasoline Exposure on Electrolytes Level Across Age Groups

Table 3 reveals the mean levels of presents the mean levels of Na^{+}, K^{+}, HCO_3^{-} and Cl^{-} among petroleum attendants exposed to gasoline across different age groups. Result showed no significant difference in the levels of Na^{+}, K^{+}, HCO_3^{-} and Cl^{-} across the different age brackets.

Effect of Gasoline Exposure on Electrolytes Level Across Age Groups

The Creatinine (mmol/L), Urea (mmol/L), AST (IU/L), ALT (IU/L), ALP (IU/L), and GGT (IU/L) levels of petroleum station attendants exposed to gasoline for age brackets 26-35 years and 36-45 years were significantly elevated in comparison to the age bracket 18-25 years. However, the ALP level of the age bracket 26-35 years, and 36-45 years was significantly lower when compared to the age bracket 18-25 years.

Table 3 Effect of Gasoline Exposure on Electrolytes Level Across Age Groups

Group	**Na^{+}(mmol/L)**	**K^{+}(mmol/L)**	**HCO_3^{-}(mmol/L)**	**Cl^{-}(mmol/L)**
18 -25years	138.25±1.26^{a}	3.71±0.12^{a}	25.58±0.29^{a}	101.50±0.74^{a}
26-35years	138.94±0.86^{a}	3.75±0.11^{a}	25.19±0.34^{a}	100.63±0.85^{a}
36-45years	136.00±1.70^{a}	3.67±0.14^{a}	24.58±0.45^{a}	101.67±1.09^{a}

Values represent the Mean ± Standard Error of Mean of the sample.(n= 60). Means in same column with different superscript alphabets are significantly different at $p<0.05$.

Table 4 Effect of Gasoline Exposure on Kidney and Liver Function Markers Across Age Groups

Age Group	Creatinine (mmol/L	Urea (mmol/L)	AST (IU/L)	ALT (IU/L)	ALP (IU/L)	GGT (IU/L)
18-25years	60.00±1.74^{a}	2.49±0.09^{a}	28.25±2.46^{a}	23.00±2.21^{a}	86.08±16.22^{a}	28.08±3.86^{a}
26-35years	66.25±1.68^{b}	2.73±0.05^{b}	19.44±2.33^{b}	19.63±1.92^{b}	63.56±6.78^{b}	35.00±8.06^{b}
36-45years	71.67±2.41^{c}	2.87±0.18^{c}	33.50±5.09^{a}	28.92±4.63^{c}	63.50±12.13^{b}	69.25±30.97^{c}

Values represent the Mean ± Standard Error of the Mean of the sample. (n= 60). Means in the same column with different superscript alphabets are significantly different at $p<0.05$.

DISCUSSION

Occupational risks associated with petroleum and petroleum products have become a subject of public health concern. The health impacts of exposure as well as regulatory bodies(Saunders et al., 2018). The duration of exposure has been a major factor impacting the health status of individuals exposed to gasoline (Adgate et al., 2014). Gasoline station workers are regularly exposed to harmful toxins from vapors of gasoline. The most prominent among these hazardous vapors is benzene fume. These can cause abnormal alterations in the functioning of many vital organs and hence increase the risk of organ damage (Abdel Aziz & Al Agha, 2006). The findings of the current study indicate that the inhalation of gasoline by participants caused alteration in electrolyte levels. Electrolyte balance plays a major role in regulating fluid distribution, maintaining osmotic pressure, cellular acid-base equilibrium and neuro-muscular activity (Yakubu et al., 2003). Serum concentrations of electrolytes including Na^+, K^+, Cl^- and HCO_3^- are vital tools used to indicate the functional integrity of the kidney. Homeostatic disequilibrium pointed out by electrolyte imbalance could be an indication of kidney dysfunction (Garba et al., 2007; Krishna & Ramachandran, 2009). The observed imbalance in the electrolyte regulation in the exposed group could suggest that the toxins from gasoline harmfully impact the nephrons and impede their function (Krishna & Ramachandran, 2009). Serum creatinine and urea are good biomarkers of renal damage by environmental pollutants, A rise in serum creatinine and urea has been recognized as a good diagnostic marker of renal dysfunction (Tizhe et al., 2014). This suggests therefore that the elevated levels of serum urea and creatinine detected in the exposed groups may suggest a reduced glomerular filtration rate and kidney function in the test subjects. Other studies have presented findings which agree with the findings of the current study (Asefaw et al., 2020; Ogunneye et al., 2014; Nwanjo & Ojiako, 2007). The liver function parameters AST, ALT and ALP were elevated in the exposed study participants in comparison to the control subjects. However,the GGT level was significantly lowered in the short- and medium-term exposed groups. Elevated serum concentrations of hepatic enzymes are commonly associated with lesions of hepatic origin. Asefaw et al (Asefaw et al., 2020) explained that hydrocarbons, a major component of petroleum products are metabolized to free radicals. The liver by Cytochrome P 4502E1 oxidative pathways which contribute to the production of free radicals and quinone metabolites such as phenol, hydroquinone, benzoquinone; 1,2,4 – benzenetriol. These free radicals and toxic metabolites cause lipid peroxidation and damage to the hepatic cell membrane, causing the release of liver enzymes in the circulation. The findings of this current study correlated reports of previous studies(El-Said & El-Noueam, 2010; Gali et al., 2012; Moro et al., 2017; Ekpenyong & Asuquo, 2017). However, the findings of this study differed from the report of Asefaw et al (Asefaw et al., 2020), in showing an elevated level of ALP in exposed test groups.

Gamma-glutamyl transferase (GGT) is a key enzyme in the metabolism of Glutathione and performs important roles in antioxidant mechanisms. Given its role as a major antioxidant, GGT has been known as a surrogate marker of oxidative stress and various studies have reported the involvement of GGT in the pathogenesis of various diseases such as cardiovascular disease (CVD), cancer, lung inflammation and neurologic diseases (Brennan et al., 2022; Corti et al., 2020). The mechanism of action deemed causative for the organ damage in oxidative stress. The toxic gaseous components of gasoline could precipitate the production of toxic metabolites

Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 123-132
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

which lead to organ stress. In the current study, exposure to petroleum and petroleum products show a positive correlation between the levels of kidney and liver function markers and duration of exposure. Laboratory tests for creatinine, urea AST, ALT,ALP and GGT for gas station participants with exposure duration of more than 5 years showed a significant increase when compared to respondents with duration of exposure of 1-2years and 3-5years. These findings are in concord with similar research which have previously reported parallel findings (Ogunneye et al., 2014; Nwanjo & Ojiako, 2007; Jabir et al., 2016; Olmedo-Buenrostro et al.,2017). Further, the study reveals that the effects of gasoline exposure correlate positively with the age of petroleum station attendants for some biomarkers assessed such as creatinine, urea, AST, ALT and GGT levels. This suggests that the age of gasoline station workers could be a major contributing factor to the impact of exposure and the health status of individuals affected.

CONCLUSION

Exposure and inhalation to gasoline and petroleum products by petrol station attendants showed an elevation of some liver and kidney function biomarkers. This is more prominent in petrol station attendants exposed for over five years. Older workers exhibited higher levels of creatinine, urea, AST and GGT indicating greater organ stress and heightened vulnerability to adverse health effects. These findings underscore the need for age specific health monitoring and protective measures for workers exposed to gasoline.

Acknowledgements

We would like to acknowledge the volunteers who participated in this study for their kind collaboration.

REFERENCES

Abdel Aziz, I.I. and Al Agha, S.Z., 2006. Hematological and Biochemical Studies for Gasoline Toxicity Among Gasoline Workers in Gaza Strip. *Al-Aqsa University Journal (Natural Sciences Series)*, *10*(SE), pp.41-58.

Adgate, J.L., Goldstein, B.D. and McKenzie, L.M., 2014. Potential public health hazards, exposures and health effects from unconventional natural gas development. *Environmental science & technology*, *48*(15), pp.8307-8320.

Al Madhoun, W.A., Ramli, N.A., Yahaya, A.S., Yusof, N.F., Ghazali, N.A. and Sansuddin, N.U., 2008. A framework for monitoring and modelling of BTEX in various development statuses in Penang Malaysia. In *International Conference of Environment*.

Asefaw, T., Wolde, M., Edao, A., Tsegaye, A., Teklu, G., Tesfay, F. and Gebremariam, G., 2020. Assessment of liver and renal function tests among gasoline exposed gas station workers in Mekelle city, Tigray region, Northern Ethiopia. *PloS one*, *15*(10), p.e0239716.

Brennan, P.N., Dillon, J.F. and Tapper, E.B., 2022. Gamma-Glutamyl Transferase (γ-GT)–an old dog with new tricks?.*Liver International*, *42*(1), pp.9-15.

Corti, A., Belcastro, E., Dominici, S., Maellaro, E. and Pompella, A., 2020. The dark side of gamma-glutamyltransferase (GGT): Pathogenic effects of an 'antioxidant'enzyme. *Free Radical Biology and Medicine*, *160*, pp.807-819.

Delanghe, J.R. and Speeckaert, M.M., 2011. Creatinine determination according to Jaffe—what does it stand for?. *Nephrology Dialysis Transplantation Plus*, *4*(2), pp.83-86.

Ekpenyong, C.E. and Asuquo, A.E., 2017. Recent advances in occupational and environmental health hazards of workers

exposed to gasoline compounds. *International journal of occupational medicine and environmental health*, *30*(1), pp.1-26.

El-Said, K., & El-Noueam, A. (2010). Biological monitoring of fuel stations workers occupationally exposed to petroleum products. *Journal of High Institute of Public Health*, *40*(3), 586-595.

Fogh-Andersen, N., Wimberley, P.D., Thode, J. and Siggaard-Andersen, O., 1984. Determination of sodium and potassium with ion-selective electrodes. *Clinical chemistry*, *30*(3), pp.433-436.

Folabi, T. and Phan, T., 2020. Evaluation of volatile organic compounds and polyaromatic hydrocarbons in Barker Reservoir in Houston, Texas after the 2017 Hurricane Harvey. *American Journal of Analytical Chemistry*, *11*(11), pp.376-388.

Gali, R., Daja, A., Mamza, Y., Ani, G. and Ani, G., 2012. Liver enzymes and protein among petrol hawkers and petrol-pump attendants in a Nigerian population. *Adv Lab Med Int*, *2*(3), pp.123-129.

Garba, S.H., Adelaiye, A.B. and Mshelia, L.Y., 2007. Histopathological and biochemical changes in the rats kidney following exposure to a pyrethroid based mosquito coil. *J Appl Sci Res*, *3*(12), pp.1788-93.

Gjerde, H. and Mørland, J., 1985. Determination of gamma glutamyltransferase in completely haemolysed blood samples. *Scandinavian Journal of Clinical and Laboratory Investigation*, *45*(7), pp.661-664.

Gunathilaka, M.L., Niriella, M.A., Luke, N.V., Piyarathna, C.L., Siriwardena, R.C., De Silva, A.P. and de Silva, H.J., 2017. Possible gasoline-induced chronic liver injury due to occupational malpractice in a motor mechanic: a case report. *Journal of Medical Case Reports*, *11*, pp.1-4.

Harper, C., &Liccione, J. J. (1995). Toxicological profile for automotive gasoline. *US Department of Health and Human Services, Agency for Toxic Substances and Disease Registry. Washington, DC: GPO*.

Jabir, M.S., Khalil, O.A., Taqi, Z.J. and Hussain, H.A., 2016. Biochemical Changes in Hepatic Function of Petrol Station Attendants in Basrah. *Al-Nahrain Journal of Science*, *19*(4), pp.135-138.

Jaishankar, M., Tseten, T., Anbalagan, N., Mathew, B.B. and Beeregowda, K.N., 2014. Toxicity, mechanism and health effects of some heavy metals. *Interdisciplinary toxicology*, *7*(2), pp.60-72.

Jasper, M.N., Martin, S.A., Oshiro, W.M., Ford, J., Bushnell, P.J. and El-Masri, H., 2016. Application of biologically based lumping to investigate the toxicokinetic interactions of a complex gasoline mixture. *Environmental Science & Technology*, *50*(6), pp.3231-3238.

Kim, S.Y., Choi, J.K., Cho, Y.H., Chung, E.J., Paek, D. and Chung, H.W., 2004. Chromosomal aberrations in workers exposed to low levels of benzene: association with genetic polymorphisms. *Pharmacogenetics and Genomics*, *14*(7), pp.453-463.

Krishna, H. and Ramachandran, A.V., 2009. Biochemical alterations induced by the acute exposure to combination of chlorpyrifos and lead in Wistar rats.

Kunutsor, S.K., Apekey, T.A., Seddoh, D. and Walley, J., 2014. Liver enzymes and risk of all-cause mortality in general populations: a systematic review and meta-analysis. *International journal of epidemiology*, *43*(1), pp.187-201.

Langenfeld, N.J., Payne, L.E. and Bugbee, B., 2021. Colorimetric determination of urea using diacetylmonoxime with strong acids. *PLoS One*, *16*(11), p.e0259760.

Scientia Africana, Vol. 23 (No. 5), December, 2024. Pp 123-132
© Faculty of Science, University of Port Harcourt, Printed in Nigeria *ISSN 1118 – 1931*

Moro, A.M., Brucker, N., Charão, M.F., Baierle, M., Sauer, E., Goethel, G., Barth, A., Nascimento, S.N., Gauer, B., Durgante, J. and Amaral, B.S., 2017. Biomonitoring of gasoline station attendants exposed to benzene: Effect of gender. *Mutation Research/Genetic Toxicology and Environmental Mutagenesis*, *813*, pp.1-9.

Neghab, M., Hosseinzadeh, K. and Hassanzadeh, J., 2015. Early liver and kidney dysfunction associated with occupational exposure to sub-threshold limit value levels of benzene, toluene, and xylenes in unleaded petrol. *Safety and health at work*, *6*(4), pp.312-316.

Nwanjo, H.U. and Ojiako, O.A., 2007. Investigation of the potential health hazards of petrol station attendants in Owerri Nigeria. *Journal of Applied Sciences and Environmental Management*, *11*(2).

Ogunneye, A.L., Omoboyowa, D.A., Sonibare, A.L., Adebusuyi, A.J. and Faniran, T.P., 2014. Hepatotoxic and nephrotoxic effects of petroleum fumes on petrol attendants in Ibadan, Nigeria. *Nigerian Journal of Basic and Applied Sciences*, *22*(3-4), pp.57-62.

Olmedo-Buenrostro, B.A., Ortega-Ortiz, J.G., Guzman-Esquivel, J., Delgado-Enciso, O.G., Ceja-Espiritu, G., Paz-Michel, B.A., Rodriguez-Sanchez, I.P., Martinez-Fierro, M.L., Baltazar-Rodriguez, L.M., Melnikov, V. and Rodriguez-Hernandez, A., 2017. Workplace gasoline exposure increases the risk for early renal dysfunction: A case-control study in Mexico. *Biomed Res*, *28*(22), pp.9859-9863.

Pauss, A., Roza, A., Ledrut, M.J., Naveau, H. and Nyns, E.J., 1990. Bicarbonate determination in complex acid-base solutions by a back-titration method. *Environmental technology*, *11*(5), pp.469-476.

Rej, R. and Shaw, L.M., 1984. Measurement of aminotransferases: Part 1. Aspartate aminotransferase. *CRC Critical reviews in clinical laboratory sciences*, *21*(2), pp.99-186.

Sun, R., Zhang, J., Yin, L. and Pu, Y., 2014. Investigation into variation of endogenous metabolites in bone marrow cells and plasma in C3H/He mice exposed to benzene. *International journal of molecular sciences*, *15*(3), pp.4994-5010.

Tizhe, E.V., Ibrahim, N.D.G., Fatihu, M.Y., Igbokwe, I.O., George, B.D.J., Ambali, S.F. and Shallangwa, J.M., 2014. Serum biochemical assessment of hepatic and renal functions of rats during oral exposure to glyphosate with zinc. *Comparative Clinical Pathology*, *23*(4), pp.1043-1050.

Yakubu, M.T., Bilbis, L.S., Lawal, M. and Akanji, M.A., 2003. Evaluation of selected parameters of rat liver and kidney function following repeated administration of yohimbine. *Biokemistri*, *15*(2), pp.50-56.