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Exposure to Petrol on the Liver and the Kidneys of Auto-mechanics in Aba Metropolis South-East, Nigeria; Age and Duration Effects

Anya, Ojiugo Hannah[1*], Nwachuku, Edna Ogechi[1], Bartimaeus, Ebirien-Agana Samuel[1] and H. A. Waribo[1]

[1]Department of Medical Laboratory Science, Rivers State University, Nkpolu Oroworukwo, Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author BEAS designed the study, performed the statistical analysis, author NEO wrote the protocol, while author AOH wrote the first draft of the manuscript and managed the analyses and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The aim of this study was assess exposure to petrol on the liver and the kidney of Auto-mechanics in Aba Metropolis, South-East, Nigeria, considering age and duration effects.
Study design: This study is a cross-sectional study.
Place and Duration of Study: Abia State University Teaching Hospital, Aba, Abia State and Laboratory Department, JAROS Inspection Services Limited, Port Harcourt, Rivers State, between April 2018 and June 2018.
Methodology: A total of 204 samples comprising of 123 auto-mechanics and 81 non -auto-mechanics were assayed. Detailed information of the bio-data of the subjects including age, gender, medical history, health information and lifestyle were obtained from each participant. Blood samples were collected from for the analysis of serum urea and creatinine level and enzyme activity of AST, ALT and ALP using selectra P*R*o*S*. The effect of age and the duration of exposure were also determined.

**Corresponding author: E-mail: anyaojugo7@gmail.com;*

Results: Statistics showed no significant variation in the mean urea ($p>0.05$) between the exposed and the control but, there was significant increase in the mean creatinine, AST, ALT, and ALP ($p<0.05$) in the exposed compared with the control participants. Out of the 123 of the exposed individuals, 29 (23.7%), 23 (18.6%), 4 (3.2%) and 40 (37.4%) had serum AST, ALT, ALP and creatinine level, above the reference value, for health respectively.
Conclusion: This study shows that the auto-mechanics are occupationally exposed to toxic chemicals and are prone to future hepato and renal pathology events.

Keywords: Petrol, liver; kidney; auto-mechanics; aba metropolis; age; duration.

1. INTRODUCTION

Hepatic and renal toxicity, due to both short and long term exposures to petrol and petroleum products has been reported [1][2]. Epidemiological studies show that liver and renal pathologies contributes to the leading cause of global non-communicable disease death toll. Over 2 million is needing dialysis but only 10% needs this treatment to survive [3][4]. Studies from 112 developing countries show that only 20% receive treatment. The rest 80% is unable to receive due to financial burden, as a result approximately one million die annually of chronic kidney disease (CKD), worldwide. It is estimated that the death toll will increase over the years especially in India where there are many old people and increasing number of aged people [5]. In Uruguay the annual estimated cost of dialysis is $ US 23million, representing 30% of national budget for resources fund for specialized therapies. In the world it is estimated that in people aged (65-74) years one out of five men and one out of four females will have chronic kidney failure. Non communicable diseases such as heart disease diabetes, kidney and liver disease have replaced communicable diseases such as Influenza malaria anti-immune deficient syndrome (AIDs) as the most common causes of premature death [3].

Over the decades chronic diseases have constituted a world-wide health crises. In the year 2005, 35 million deaths out of 58 million deaths were contributed by chronic diseases [6]. Many factors contribute to these communicable disease including, nutritional status, immunity, lifestyle, chronic exposure to environmental toxicants, lack of exercise, sanitary conditions and geographical location [7-10].

Aspartate amino transferees (AST) also known as serum glutamic-oxaloacetic tranceaminase (SGOT) is found in the most tissues of the body. Higher concentrations are found in the cells of the heart and liver but much lower in the kidneys and muscles. Studies have shown that, AST enzymes are released into the blood following the exposure to toxic chemicals [1] [11]. This provides the bases for its use as a diagnostic tool for assessing damage to the heart (as in myocardial infarction) and liver disorders (increase in serum AST may be up to 100 times the normal serum level in viral hepatitis). Serum AST also serve as a tool for monitoring parameter in the pathology of the heart and liver [12] [13]. AST activity increases within the first eight hours of onset of liver pathology and after twenty four hours will gradually reduce to lower enzyme activity in the serum.

Alanine aminotranseferase (ALT) or serum glutamic pyruvic acid tranceaminase (SGPT) is an enzyme that catalyses the deamination of alanine and the transfer of amino group to glutamic acid to give glutamine and pyruvate at pH7.4. ALT like AST is found in many tissues of the body but it is found mainly in the liver [13]. However unlike AST, the activity of ALT rises gradually in liver disorders and continue to increase in its activity to very high serum values than AST. Alanine aminotransferase has been reported as a more specific enzyme than AST and ALP for detecting liver disorder. In some cases of liver function test results, where the activity of ALP and AST enzymes in the serum may be low, an increased or high value of ALT is an acceptable indicator for the pathology of the liver. Serum samples for enzyme analysis are stable for one week at 4^0C [12] [13].

Alkaline phosphatase is metallo-enzyme produced in the bone matrix. It plays a major role in the calcification process in bone development. Alkaline phosphatase is activated by manganese and magnesium. In alkaline pH (pH9-10). It catalyses the cleavage of phosphoesters, in all tissues of the body [13]. It is a structural component of cell membranes and plays a transport roll in the kidney, liver, and intestinal mucosa is known to increase in many disease

conditions, liver disease, Kidney disease, bone diseases such as osteoporosis, rickets pagets disease, cancer, hyperthyroidism and severe cases of haemolyses [14]. It is not uncommon to observe high serum ALP levels in pregnant mothers and in children and teens. Exceptional high ALP levels are recorded in pregnant mothers and children possibly due to bone development [15] [16]. Various study on exposure to petrol have demonstrated increase in the ALP due to deleterious effect on the liver or kidney [2]. Alkaline phosphatase, fascilitate the calcification of the hard tissue such as in the bone development and maintainance. In soft tissues, ALP facilitates the mineralization by the provision of inorganic phosphate [17]. It is useful as a biological marker in health and many disease conditions such as bone and liver disease. Alkaline phosphatase is distinctively high levels of alkaline phosphatase of 20-25 times reference range can be observed in bone diseases [18]. Alkaline phosphatase has also, been considered as a potential biomarker for stroke through haemorrhagic blood vessel in the brain. Significant increase of ALP has been reported due to animal or human exposure to petrol and petroleum products [2].

2. MATERIALS AND METHODS

2.1 Area of Study

The area of study is Aba and its metropolis, located in the South Eastern zone of Nigeria. It lies on the geographical coordinates of $5^0$07N, $7^0$22^{0}E. The city is known for heavy traffic flow and poorly unmaintained road network. Automobiles are imported as 'fairly used' vehicles. Thus with the poorly maintained roads, many vehicles are frequently damaged and the automechanics are often engaged in automobile repairs.

2.2 Study Questionnaires and Consent Forms

Detailed information of the bio-data of the subjects including age, gender, medical history, health information and lifestyle were obtained from each participant. A total of 300 questionnaires were distributed, however only 240 individuals gave their consent. Based on inclusion criteria and exclusion criteria, blood samples were collected from 204 males comprising of 123 auto-mechanics (exposed group) and 81 non auto-mechanics (the control group). On interview it was found that most auto-mechanic were afraid of needle puncture so, many avoided the hospitals and of course laboratory tests, even, when there were ill. No female auto-mechanics was in the entire all the mechanic workshop visited. Several interviews showed that some years past, there were few female auto-mechanics, but because of the stress involved, there left the occupation.

2.3 Selection Criteria for Recruitment

2.3.1 Inclusion criteria

Those who qualified to participate in this study included, the auto-mechanics age 16 to 65years of age, who were resident in Aba Metropolis and have worked as auto-mechanics in Aba for not less than two years the exposed group and individuals who were not auto-mechanics who served as the control group. Those included were apparently healthy subjects, with no known case of chronic diseases such as liver disease, kidney disorder, hypertention, and blood related diseases such as anaemia, blood cancer, diarrhoea or under any medication within the period of this study and those who were not associated with alcoholism or smoking and those who willingly gave their consent.

2.3.2 Exclusion criteria

Blood samples were not collected from subjects who had any known acute or chronic disease condition such as liver disease, kidney disorder, CVDs, diarrhea diabetes mellitus and subjects undergoing medication whether herbal or orthodox. Individuals associated with alcoholism, drug addicts, smokers and those who were were not willing to give their consent were excluded.

2.4 Collection of Samples

Sample containers and centrifuge tubes were carefully labeled on two different sides. This was done to avoid loss of identity of samples following the removal of any of the labels during sample handling. Blood was manually collected using the method of [19]. A toniquet was tied on the arm of the seated participant. The area was swabbed with 70% treated cotton wool, then with a ten milliliter sterile needle and syringe blood was collected from the cubital vein and the distributed into various bottles and centrifuge tubes. Samples were collected in batches for easy handling and analyses. Blood in the syringe was emptied into prelabelled centrifuge tube and allowed to clot. Then sample was centrifuged at

5000 revolutions per minute for 5min. With sterile disposable rubber pipettes, serum sample was separated into sterile sample bottles for the determination of other biochemical parameters.

2.5 Laboratory Analyses

2.5.1 Determination of aspartate aminotransferase

Aspartate Aminotransferase was determined by kinetic method of [20], which the principle **is** thus; AST catalyses the deamination of Aspartate to give oxaloacetate and L Glutamine in the presence of alpha ketoglutaric acid at 37^{o}c. Malate dehydrogenase catalyzes the breakdown of oxalocetate in the presence of NADH and H to give Malate and NAD.

2.5.2 Determination of alanine aminotransferase

The enzyme Alanine Aminotransferase was determined with the kinetic method of [20]. Alanine aminotranseferase kinetically catalyses deamination of alanine to give pyruvate and L-glutamate. Further catalytic action of lactate dehydrogenase breaks down pyruvate to give lactate and NAD.

2.5.3 Determination of alkaline phosphatase

Alkaline phosphatase activity was determined with kinetic method of [21]. Alkaline Phosphatse catalyses the cleavage of para-nitrophenyl phosphate to give para-nitrphenol and inorganic and inorganic phosphate at 37^{O}C.

2.5.4 Determination of urea

Urea was determined with the modified Berthelot method of [22], using Agappe kit from agappe diagnostics (Chan Switzerland). In this method urea, in the presence of nitripruside and hydrochlorite the enzyme urease catabolise the breakdown of urea to give 2, 2-Dicarboxy Indophenol.$_3$ and salicylate.

2.5.5 Determination of serum creatinine

Urea was determined by the modified Jeffe reaction according to [23] with agappe kit from, Agappe diagnostics, Chan, Switzerland. In an alkaline condition creatinine reacts with picric acid to give a yellow product (creatinine picrate). The intensity of the yellow colour produced is proportional to the concentration of creatinine in the serum sample. Laboratory analysis was carried out in a fully automated chemistry analyzer selectra P*R*o*S* from. The cleaning, testing for accuracy of equipment and the preparation of calibration curves appropriate reagents, standard and control sera preceded the analysis according to the instructions on the manufacturer's manual. The value of creatinine was read from standard curve with reference range [78-103] µMol/litre.

2.6 Statistical Analysis

Statistical Analysis System (SAS), STAT 15.1, developed by SAS Institute, North Carolina State University, USA was used for statistical analysis. Data were presented as Mean ± SEM, comparison of means of groups that are more than two was done using Analysis of Variance (ANOVA), and the Tukey test of multiple comparison was used to test for variance within and across groups. Variation between two groups was done using the Student t-test analysis while Chi square analysis was used to compare percentages. The Pearson's correlation was used to determine the correlations between parameters. Variation in means of parameters was considered statistically significant at $p<0.05$.

3. RESULTS AND DISCUSSION

The liver is an organ acquainted with detoxification [24]. Harmful substances or xenobiotics such as polycyclic aromatic hydrocarbons and heavy metals may pass through many tissues and organs but they are metabolized in the liver into lesser harmful substances which are subsequently excreted in through urine, saliva, skin and stool [13]. In this study there was significant increase in the mean ±SEM of liver enzymes (AST, ALT and ALP) in the exposed compared to the control group ($p<0.05$) (Table 1). The mean AST of the exposed group, was significantly higher compared to the control group, ($p<0.05$).The mean ALT of the exposed group, was significantly higher compared to the control group, ($p<0.05$). Also the mean ALP of the exposed group, was significantly higher compared to, recorded for the control group, ($p<0.05$).

Table 1. Liver Enzymes (AST, ALT and ALP) and Kidney parameters (Ur and Cr)

Parameter	Control (n =123)	Exposed (n = 81)
AST (U/L)[29]		
>46	29 (23.6%)	1 (1.2%)
<46	97 (86%)	80(98.8%)
ALT (U/L)[29]		
>49	23 (18.6%)	0 (0%)
< 49	100 (81.4%)	80(100%)
ALP(U/L)[30]		
> 306	4 (3.2%)	3(3.7%)
< 306	119(96.8%)	78(96.3%)
Ur (mMol/L)[31]		
> 9.13	2(1.6%)	0 (0%)
< 9.17	119 (96.4%)	81(100%)
Cr µMol/ l)[32]		
>107	40 (37.4%)	10 (12.5%)
< 107	83(63.6%)	71 (87.5%)

Abbreviation : n = number of samples, AST = Aspatate amino transferase, ALT = Alanine amino transferase ALP = Alkaline phosphatase, Ur = Urea and Cr = Creatinine

Although the parameters were within the reference range health result shows hepatoxic effect due to exposure to petrol and petroleum products in the auto-mechanics compared to the nonauto-mechanics. Chronic exposure has been reported to cause deleterious effect on the liver cells [25].

This is usually situations where the liver is unable to cope with the level of exposure and detoxification process may not be adequate to remove the toxic substances. This contributes to increased activity of the liver cells and the reduction in the life-span of Kupfer cells [25]. Although the serum level of these liver enzymes were within the reference range for health in the exposed and in the control groups, increased liver enzymes in the exposed suggest the susceptibility of the auto-mechanics to suffer liver pathology in the future compared to the non auto-mechanics. These findings are similar to the studies in India [26] [27] in which automobile workers exposed to fumes of gasoline and lead had significant increase in their liver enzymes, AST and ALT compared to the unexposed (control) groups. In another study in Pakistan [28] there was significant increase in AST and ALP of petrol filling stations attendants and automobile garage attendants compared with the control group.

A study on asymptomatic petrol depot workers in Calabar, south in Nigeria showed significant increase in the activity of the liver enzymes AST, ALT and ALP [29]. The reason for this increase in the liver enzymes was attributed to the exposure to petrol fumes and heavy metals with subsequent damage to the cell membrane of Kupfer cells. These enzymes were thus released from damaged liver cell membranes into the blood.

Despite the clamour by the developed world to remove lead from gasoline it was found that even early exposure 200 workers of in Shiraz petrol station who were exposed to unleaded petrol had significant increase in AST and ALT compared to the unexposed group suggesting hepatoxic effect (Table 2). The reason for this increase was linked to the presence of highly toxic petroleum products [2] known as monohydrocarbons (benzene and xylenes and toluene). Contrary to the present study, exposure of male workers aged 20-45 years to petroleum products showed no significant difference in the liver enzymes between those exposed to fumes and the non-exposed [30].

It was attributed to shorter duration. Increased age and duration of exposure may alter the effect. In this study the age range was 18 – 60yrs.

There was significant difference in the mean of the liver enzyme (AST and ALT) in the age groups between the exposed and the control groups ($p<0.05$), but there was no significant difference observed in the mean ALP ($p> 0.05$).Similar to this study, it was recorded that exposure of taxi-drivers showed significant difference in the liver enzymes which increased with duration of exposure.

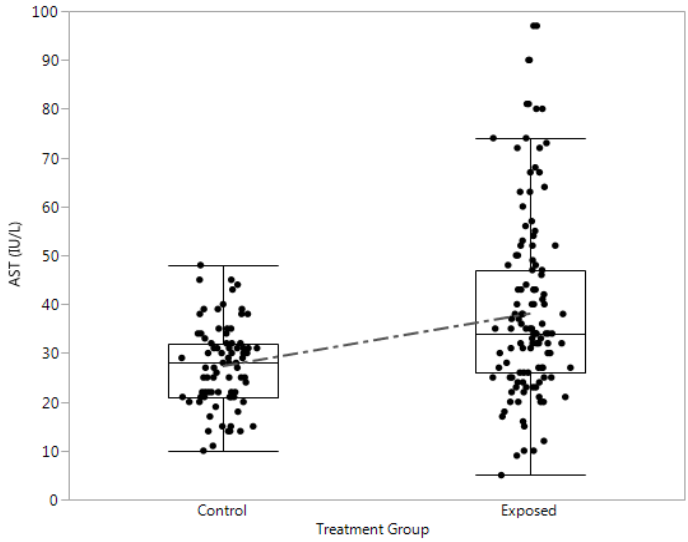

Fig. 1. Box plot of Aspartate Aminotransferase (AST) by treatment group

Table 2. Liver Enzymes (AST, ALT and ALP) by Treatment Group and Duration of Exposure

Characteristic	n	AST (IU/L)		ALT (IU/L)		ALP (IU/L)	
		Mean ± SEM	P-value	Mean ± SEM	P-value	Mean ± SEM	P-value
Treatment Group							
Auto mechanic (Exposed)	123	38.08±1.57 [a]	<0.0001****	35.77±1.50 [a]	<0.0001****	187.07±6.69 [a]	0.0021**
Non-auto mechanic (Control)	81	27.32±0.95 [b]		26.19±1.15 [b]		154.24±8.11 [b]	
Duration of Exposure (Years)[β]							
<=5	31	48.13±3.63 [a]		42.71±3.78 [a]		237.74±18.81 [a]	
6-10	14	39.00±4.82 [b]		37.43±4.85 [b]		171.14±19.16 [b]	
11-20	34	32.24±1.74 [c]	0.0001****	31.65±2.20 [c]	0.0356*	166.85±08.76 [c]	0.0001****
21+	44	35.25±2.58 [c]		33.55±2.10 [c]		172.07±19.16 [b]	

*Abbreviations: SEM: Standard error of mean, AST:Aspartate Aminotransferase, ALT: Alanine Amino Transferase, ALP: Alkaline Phosphatase.[β] Applies only to participants in the exposure group (Auto mechanics);Within each Characteristic, means ± SEM with different superscripts are significantly different at p<0.05.Significance Level: *=p<0.05; **=p<0.01; ****=p<0.0001; ns=Not Significant (p>0.05)*

In this study significant difference was also observed in the mean of the liver enzymes (AST, ALT and ALP) between the duration of exposure groups (p<0.05) and for the ALP there was a decrease in the activity at <5yrs group of exposure compared to the exposure group 21yrs+ (Table 3). But for the AST and ALT enzyme activities were reduced at the peak of duration of exposure >21yrs. Toxicity not only depends on the years of exposure but depends

also on the degree of exposure to the chemical. It was observed that the younger and the new persons in the auto-mechanic workshops were those that frequently siphon or mouth pipette, petrol while the longer in the service coordinate the activities of the workshop. Increase in the ALP of the newly employed auto-mechanics were mainly among the younger group <5yrs duration with age < 20yrs. These group are still in the bone developing period. Alkaline phosphatase is important in bone development.

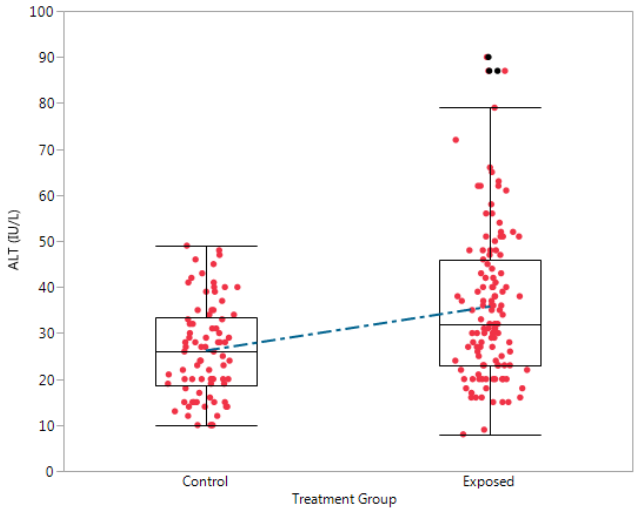

Fig. 2. Box plot of Alanine Amino Transferase (ALT) by treatment group

Table 3. Liver Enzymes (AST, ALT and ALP) of Treatment Group by Age Classification

Age group (Years)	Treatment Group	n	AST (IU/L) Mean ± SEM	ALT (IU/L) Mean ± SEM	ALP (IU/L) Mean ± SEM
< 25	Auto mechanic	27	48.44±2.72^{a}	44.93±2.69^{a}	237.56±13.80
	(Exposed)	41	26.02±2.21^{d}	23.88±2.18^{d}	156.76±11.20
	Non-auto mechanic (Control)				
25 – 34	Auto mechanic	26	36.88±2.77^{b}	31.77±2.74^{bc}	170.19±14.06
	(Exposed)	21	28.29±3.08^{cd}	28.33±3.05^{cd}	165.90±15.64
	Non-auto mechanic (Control)				
35 – 44	Auto mechanic	30	32.23±2.58^{bcd}	32.33±2.55^{bc}	171.20±13.09
	(Exposed)	11	28.82±4.26^{bcd}	28.73±4.21^{bcd}	141.36±21.62
	Non-auto mechanic (Control)				
45 -54	Auto mechanic	27	36.48±2.72^{b}	36.63±2.69^{b}	179.70±13.80
	(Exposed)	6	28.17±5.77^{bcd}	23.83±5.70^{cd}	132.67±29.27
	Non-auto mechanic (Control)				
55+	Auto mechanic	13	35.85±3.92^{bc}	30.92±3.87^{bcd}	167.92±19.88
	(Exposed)	2	33.00±10.00^{abcd}	44.00±9.87^{abc}	115.50±50.69
	Non-auto mechanic (Control)				
Test Statistic, P-Value			0.0109**	0.0010***	0.0894^{ns}

*Abbreviations: SEM: Standard error of mean, AST:Aspartate Aminotransferase, ALT: Alanine Amino Transferase, ALP: Alkaline Phosphatase.Within each parameter, means ± SEM with different superscripts are significantly different at p<0.05. Significance Level: **=p<0.01; ***=p<0.001; ns=Not Significant (p>0.05)*

Table 4. Kidney Function Tests Urea and Creatinine of the Treatment Group and the Duration of Exposure

Characteristic		Urea (mMol/L)		Creatinine (uMol/L)	
		Mean ±SEM	P-value	Mean ± SEM	P-value
Treatment Group					
Auto mechanic (Exposed)	123	4.48±0.69		104.60±2.45[a]	
Non-auto mechanic (Control)	81	3.14±0.09	0.1199[ns]	79.20±2.34 [b]	<0.0001****
Duration of Exposure (Years)[β]					
<=5	31	6.63±2.69		116.84±6.41 [a]	
6-10	14	3.69±0.48		101.43±5.71[b]	
11-20	34	3.60±0.23		99.44±2.91[b]	
21+	44	3.89±0.25	0.3489 [ns]	100.98±4.00[b]	0.0349*

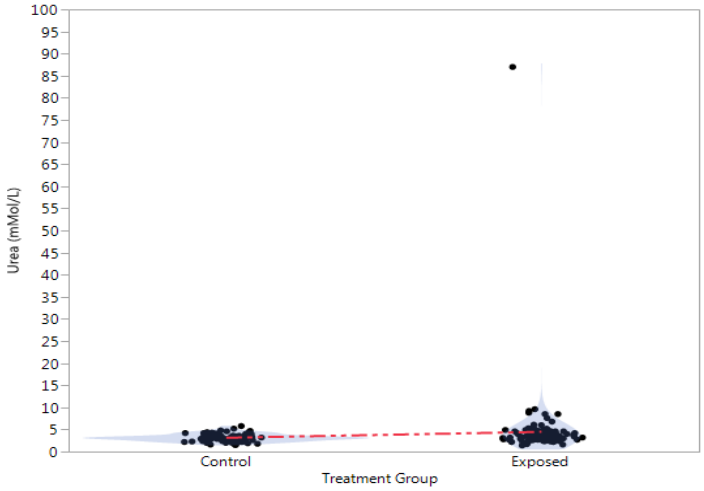

Fig. 3. Box plot of urea (mMol/L) by treatment group

According to the national institute of health, chronic kidney disease (CKD) is approximately 14% .The most common causes of CKD include diabetes mellitus and hypertension and exposure to environmental pollutants, [31].

The kidney is an important organ in the removal of water soluble waste substances from the body [24]. Xenobiotics such as petroleum and petroleum constituents are conjugated usually with glucoronic acid and are excreted in urine as glucoronides [13]. In this study the mean serum creatinine of the exposed group was significantly increased compared to the value recorded for the control group ($p< 0.05$) (Table 4). But, there was no significant difference between the mean urea concentration of the exposed and the control groups ($p >0.05$). In a study of taxi drivers ,exposed to polycyclic aromatic hydrocarbon in an urban city, Rio Grande do Sul, South of Brazil, [32] and petrol attendants in the Owerri city, south- east of Nigeria [33] significant increase in the mean creatinine was recorded for the exposed compared to the control group. In another study of individuals exposed to the flaring of petroleum product (in Texas City), a similar report showed significant increase in the mean creatinine level [1].

According to these reports, the severe alteration in the creatinine level may have been contributed to the multiple toxic chemicals and volatile constituents from petrol, inhaled from the air. Earlier studies in Sulaimaniya city [34] in India

[27] and at Nnewi metropolis, Nigeria [35] significant increase in creatinine and in urea was recorded in individuals exposed to petrol fumes and lead compared to the control (Table 5). The significant increase in creatinine and urea was attributed to chronic exposures. Contrary to the report on the mean creatinine obtained in this study and in agreement to the mean urea level, non-significant difference was observed between the exposed and the control for creatinine and urea levels of auto-mechanics in the city of Addis Ababa, in Ethopia [36]. Similar findings were also reported in North West of Pakistan [37] and in Sulimaiya city [38].

This finding was attributed to shorter duration of exposure. Discordant report on exposure to petrol fumes showed significant increase within short duration for the mean urea and creatinine levels [2]. With significant increase in the mean creatinine of auto-mechanics in this study it was expected that there will also be significant increase in the mean urea. Serum urea level is known to be unstable and may be influenced by any form of metabolic dehydration or hydration unlike creatinine which is a more stable biomarker for the assessment of kidney function [39]. On interview it was found that auto-mechanics seemed to be, prone to drinking more water and may take more fluid, than the non auto-mechanics because of the peculiarity of their occupation. Rehydration may have contributed to the serum urea level recorded in the auto-mechanics. Moreover urea is a product of protein breakdown in the liver thus cellular damage or dysfunctional liver may not be able to produce urea [25], but studies have shown that, creatinine value is not affected by this change [40].

Duration of exposure to petrol and petroleum products and adverse biological alterations in the liver and kidney have been descibed variously [27] [32] [2], [41]. In this study, significant early effects were observed in the mean AST, ALT, ALP, Urea and creatinine of < 5years duration of exposure group. Although there was no significant difference in the mean Urea level, significant variation was observed between the group of < 5years duration of exposure and 6-10years, 11-21years and > 21years groups. This is in concordance with earlier studies]2] [41]. Contrary to this study, another study reported no significant variation, based on duration of exposure [38].

Although the mean creatinine of the auto-mechanics was within the reference value the significant increase suggests that the auto-mechanics are more vulnerable to nephrotoxic effect than the non auto-mechanics. In this study, there was no significant variation in the mean urea level for all age groups, between the exposed and the control individuals (p>0.05). However significant increase was observed for the mean creatinine in the exposed compared with the control groups in all age groups (p>0.05) (Table 6). This is in accordance to the study by Neghab et al [2] and contrary to the work by Mohammed et al [38].

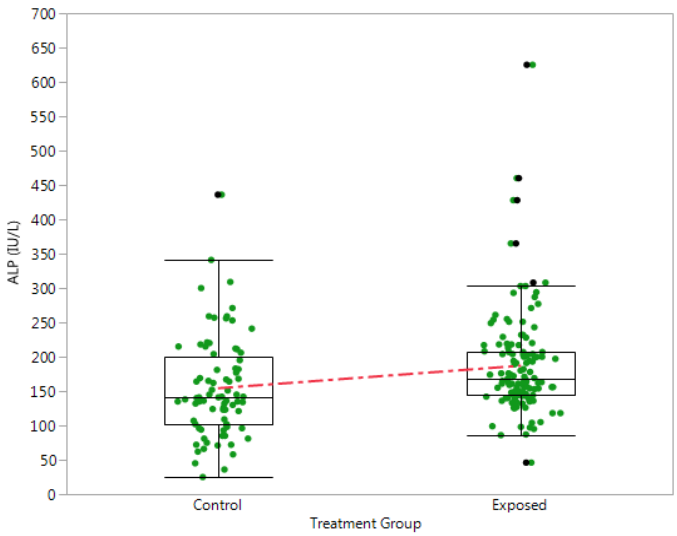

Fig. 4. Box plot of alkaline Phosphatase (ALP) by treatment group

Table 5. Kidney function test measures (Urea and Creatinine) of Treatment group by age classification

Age group (Years)	Treatment Group	N	Urea (mMol/L) Mean ± SEM	Creatinine (uMol/L) Mean ± SEM
< 25	Auto mechanic (Exposed)	27	7.03±1.15	118.44±4.70[a]
	Non-auto mechanic (Control)	41	3.21±0.94	74.27±3.82[c]
25 – 34	Auto mechanic (Exposed)	26	3.64±1.17	103.65±4.79[b]
	Non-auto mechanic (Control)	21	2.91±1.31	81.57±5.33[c]
35 – 44	Auto mechanic (Exposed)	30	3.52±1.09	99.73±4.46[b]
	Non-auto mechanic (Control)	11	3.35±1.81	89.00±7.37[bc]
45 -54	Auto mechanic (Exposed)	27	4.00±1.15	97.33±4.70[b]
	Non-auto mechanic (Control)	6	3.08±2.44	86.17±9.98[bc]
55+	Auto mechanic (Exposed)	13	4.05±1.66	104.08±6.78 [ab]
	Non-auto mechanic (Control)	2	3.25±4.23	80.50±17.28[bc]
Test Statistic, P-Value			0.5648 [ns]	0.0081**

*Abbreviations: SEM: Standard error of mean. Within each parameter, means ± SEM with different superscripts are significantly different at p<0.05. Significance Level: **=p<0.01; ns=Not Significant (p>0.05)*

Table 6. Pairwise Correlation Analysis Between Liver Enzymes and Kidney Function Test Parameters in the *Control* (Non-Auto-mechanics) and Exposed (Auto-mechanics) Groups

Parameter	By Parameter	Correlation (r)	P-value
ALT (IU/L)	AST (IU/L)	0.2465	0.0266*
Creatinine (uMol/L)	ALT (IU/L)	0.2407	0.0304*
ALT (IU/L)	AST (IU/L)	0.7016	<.0001****
ALP (IU/L)	ALT (IU/L)	0.1989	0.0274*

*Abbreviations: AST:Aspartate Aminotransferase, ALT: Alanine Amino Transferase, ALP: Alkaline Phosphatase. Significance Level: *=p<0.05; ****=p<0.0001*

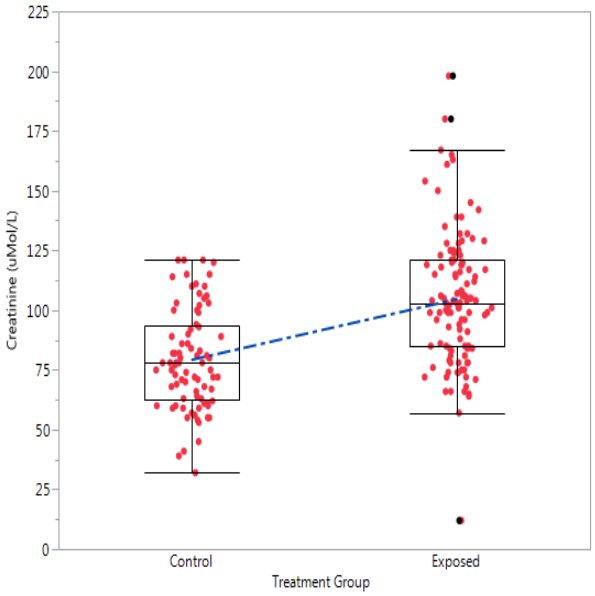

Fig. 5. Box Plot of Creatinine (*uMol/L*) by Treatment Group

There was no significant difference in the mean urea between the groups of duration of exposure ($p > 0.05$) but significant increase was observed in the mean creatinine level between the groups of exposure. Creatinine provided a better marker than urea for biological changes in the kidney. This is line with earlier studies on exposure to petrol and petroleum products [37] [38] [42].

4. CONCLUSION

This study shows that the auto-mechanics are occupationally exposed to toxic chemicals and are prone to future hepato and renal pathology events. Age and duration of exposure significantly contributed to toxic effects in the liver and kidney. Despite the significant variations, there was no significant correlation between the liver and kidney parameters. Adequate and proper monitoring of the environmental pollution and routine health check for the auto-mechanics in Aba metropolis are recommended. This will provide preventive measure to future pathology and more importantly improve the life expectancy.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

Ethical and legal standards were according to Helsinki considerations [43] WMDH, 2002). Ethical approval was given by Abia state ministry of health Umuahia, Abia State.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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