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RESEARCH ARTICLE

ASSESSMENT OF RENAL AND LIVER PROFILE AMONG LIQUEFIED PETROLEUM GAS PLANT WORKERS

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ABSTRACT

Background: Liquefied petroleum gas (LPG) has been used extensively for heating, cooking and as a fuel in vehicles and generators. This study was designed to evaluate renal and liver profile of LPG plant workers in Benin City, Edo State. **Methods:** A total of one hundred (100) subjects between 20-60 years were recruited for this study which consist 50 liquefied gas plant workers and 50 subjects who do not work in LPG plant stations (controls). Blood samples (10ml) were collected from the cubital vein of each subject with the aid of syringe and needle into plain plastic containers. The renal and biochemical parameter were analyzed using standard laboratory procedures. **Results:** The results obtained in this study show that sodium and creatinine levels of liquefied petroleum gas plant workers were significantly higher ($p<0.05$) when compared with the respective controls. There was no significant difference when the serum levels of potassium and urea were compared with the respective controls. There was significant difference ($p<0.05$) when AST, ALT, ALP, and GGT values were compared with their control. The creatinine levels were significantly higher ($p<0.05$) within the age group 41-50 years and 51-60 years. There was no significant difference ($p<0.05$) in the sodium, potassium and urea levels in the various age groups. There was no significant difference when AST, ALT, ALP and GGT were compared within the various age groups. **Conclusion:** The results of this study however showed that exposure to LPG resulted in significant renal and liver profile alterations.

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INTRODUCTION

Over the years, it has been reported that about 3.2 billion people constantly make use of coal and biomass fuels such as wood, dung and crop residues in order to meet their basic energy needs (Eva *et al.*, 2017). Liquefied petroleum gas (LPG) has been used extensively for heating, cooking and as a fuel in vehicles and generators. LPG could be referred to as auto-gas, propane and butane depending on where it is been used (Eva *et al*., 2017). It emits less greenhouse gas emissions and as such is referred to as a green fuel. It does not contain lead and sulphur, it is odorless and a non-renewable source of energy (Fukunaga, 2015). Also, it is extracted from crude oil and natural gas and it is constituted by hydrocarbons containing three or four carbon atoms.

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The normal components of LPG are propane (C_3H_8) and butane (C_4H_{10}), although concentrations of other hydrocarbons may be present. LPGs can be liquefied when pressure is applied at normal temperatures and at atmospheric pressure; it is a gas (World Health Organization, 2017). There have been reports on the health challenges accrued to the use of wood and kerosene, which therefore resulted in an increase in the use and sales of LPGs with little information on the effects of its exposure to humans (International Energy Agency, 2016). Solid fuels still remain significant in residential energy use in less developed countries despite the tremendous efforts fuels made in impacting economic development (International Energy Agency, 2016). Shifting from the use of solid fuels to modern forms of energy resulted in the use of kerosene and LPG, natural gas, electricity and biogas and has considerably improved access to modern commercial energy in the developing nations (International Energy Agency, 2016; World Liquefied Petroleum Gas Association, 2017).

The use of LPGs represents the transition into the use of modern fuels which automatically replaces the use of traditional fuels (Kojima, 2011). LPG is regarded as the major fuel for residential cooking in areas not accessible to natural gas and however could be the fuel of choice for many household even when natural gas is available (Fukunaga, 2015; World Liquefied Petroleum Gas Association, 2017). The availability and use of LPG is dependent on the income, price availability, reliability of supply, prices of other fuels, acquisition costs of LPG cylinders and stoves, fears about safety, unfamiliarity with cooking with LP Gas, lack of knowledge about the harm caused by smoke from solid fuels burned in traditional stoves and cultural preferences (Kojima, 2011). LPG as many would suggest has played a positive role in providing sustainable environmental challenges to the problem related to the scarcity of wood as fuel in households (Fukunaga, 2015). However, there is growing concern over the use of LPG among individuals who constantly inhale this substance with a reported significant higher disease burden (Sugie, 2014). This concern therefore sets this research in motion to investigate the effects of LPG on renal and liver profile of LPG plant workers.

MATERILA AND METHODS

Research Protocol: A comparative cross-sectional study was conducted on LPG plant workers in Benin City, Edo State, Nigeria, from August 1, to December 31, 2019 in which workers exposed to LPG were compared with those that are not exposed to LPG (controls). The LPG gas plant workers were all males who work between 8am to 2pm and from 2pm-8pm daily. The LPG plant workers were interviewed and blood samples were collected twice daily in the Manager's office at 12pm and 4pm daily when there were high chances of minimal work load. The control groups were interviewed, examined with no underlying and visible symptoms of any ailment before collection of blood samples. Also questionnaires were used to collect the information on age and general health status.

Study Population: A total of one hundred (100) subjects between 20-60 years were recruited for this study which consist of fifty (50) gas plant workers and fifty (50) non LPG plant workers which served as the control.

Inclusion and Exclusion Criteria: Apparently healthy LPG plant workers and controls with no underlying illness or symptoms were recruited for this study. Subjects who are not within 20-60 years, and have underlying illness or symptoms were excluded from this study.

Ethical Approval: Ethical approval was obtained from the University Research and Ethics Committee. Also, informed consent was also obtained from the subjects after explaining the purpose of the study to them.

Sample Collection: Blood samples (10ml) were collected from the cubital vein of each subject with the aid of syringe and needle into plain plastic containers. The blood sample in the plain containers was centrifuged at 3000rpm for 10 minutes and serum immediately separated from the cells into plain containers with labels corresponding to initial blood sample bottle. The serum samples were stored frozen at -70^{o}C until the time for analysis.

Sample Analysis: The samples obtained from the LPG plant workers and controls was analyzed for activities of liver enzymes (aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) and gamma glutamyl transferase (GGT) and renal function (creatinine, urea, potassium and sodium) (Reitman, 1957; Fabiny, 1971; Rec, 1972).The sera obtained were used to estimate AST, ALT, ALP, GGT, creatinine, urea, sodium and potassium using commercially available reagent kits, standard protocols and equipments.

Statistical Analysis: The results obtained in this study were analyzed statistically and the mean and standard deviation values calculated in each case. The Student t-test and Analysis of Variance (ANOVA) statistical methods were employed for comparison using a computer programme (SPSS) for window release 21.0. A p- value equal or less than 0.05 ($P \leq 0.05$) were considered statistically significant at 95% confidence level.

RESULTS

The results obtained in this study show that sodium (144.66 ± 5.60 mmol/l) and creatinine (0.71± 0.17 mg/dl) levels of liquefied petroleum gas plant workers were significantly higher ($p<0.05$) when compared with the respective control (141.76 ± 5.60 mmol/l) and (0.64 ± 0.20mg/dl). There was no significant difference when the serum levels of potassium and urea were compared with the respective controls (Table 1). The results obtained showed that there was significant difference ($p<0.05$) when AST (12.76 ± 4.22 U/L), ALT (6.48 ± 3.34 U/L), ALP, (30.40 ± 7.71 U/L) and GGT (96.03 ± 73.74 U/L) values were compared with the respective control, (7.00 ± 3.18 U/L), (4.72 ± 2.46 U/L), (23.58 ± 7.61 U/L) and (49.89 ± 38.51 U/L) (Table 2).

The results showed that serum sodium, potassium and urea were not statistically significant (($p>0.05$) within the age groups while the serum levels of creatinine were statistically significant ($p<0.05$) within the age groups of 41-50 years and 51-60 years (Table 3). The results also showed that there was no significant difference when AST, ALT, ALP and GGT were compared within the various age groups. However, AST and GGT levels were higher in the age group 20-30 years. ALT values were higher in the age group 31-40 years while ALP values were found to be higher with the age group 51-60 years (Table 4).

DISCUSSION

LPG having being regarded as a mixture of hydrocarbon gases used as fuel in vehicles and cooking appliances in homes (Prasad et al., 2017). There has not been much serious health issues reported with the use and abuse of LPG, however, there is high risk involved in workers who majorly deal with packaging and filling large quantities of LPGs. Hence this study was carried out to determine the effects of LPG on LPG plant workers by considering basic biochemical parameters.

This study showed that sodium and creatinine levels were significantly higher in LPG plant workers, while the level of potassium and urea were not significantly different, though the values tend to vary in LPG plant workers when compared with the controls. This observation is in line with the work of Sirdah *et al*., (2013) where a similar trend of result was reported.

Table 1: Renal function of Liquefied Petroleum Gas Plant Workers with the controls

Parameters	Control (n=50)	Subjects (n=50)	t-value	P-value	Remark
Sodium (mmol/l)	141.76±5.60	144.66±5.60	3.663	0.001	S
Potassium (mmol/l)	4.09±0.40	4.02±0.45	1.173	0.246	NS
Urea (mg/dl)	27.42±8.41	28.16±7.15	0.732	0.468	NS
Creatinine (mg/dl)	0.64±0.20	0.71±0.17	3.141	0.001	S

Key: n=Sample Size, S: Significant, NS: Not significant.

Table 2: Liver Function of Liquefied Petroleum Gas Plant Workers with the Controls

Parameters (U/L)	Control (n=50)	Subjects (n=50)	t-value	P-value	Remark
AST	7.00±3.18	12.76±4.22	9.649	0.000	S
ALT	4.72±2.46	6.48±3.34	3.727	0.001	S
ALP	23.58±7.61	30.40±7.71	6.258	0.000	S
GGT	49.89±38.51	96.03±73.74	4.424	0.000	S

Key: n=Sample Size, S: Significant, NS: Not significant, AST: Aspartate amino transferase, ALT: Alanine amino transferase, ALP: Alkaline phosphatase, GGT: Gamma glutamyl transferase.

Table 3: Age comparison of renal function of Liquefied Petroleum Gas Plant Workers

Parameters	20-30yrs (n=25)	31-40yrs (n=17)	41-50yrs (n=05)	51-60yrs (n=03)	F-value	P-value
Sodium (mmol/l)	145.04±6.07^{a}	143.18±5.05^{a}	149.00±4.06^{a}	142.67±3.79^{a}	1.625	0.196
Potassium (mmol/l)	3.93±0.43^{a}	4.14±0.50^{a}	4.12±0.44^{a}	3.87±0.12^{a}	0.972	0.414
Urea (mg/dl)	29.04±6.74^{a}	25.82±7.50^{a}	28.60±6.77^{a}	33.33±8.33^{a}	1.282	0.292
Creatinine (mg/dl)	0.66±0.11^{a}	0.70±0.18^{a}	0.94±0.15^{b}	0.83±0.23^{ab}	5.601	0.002

Key: Values in a row with a different superscript are significantly different at p<0.05; n=Sample Size, P<0.05: Significant, P>0.05: Not significant.

Table 4: Age comparison of liver function of Liquefied Petroleum Gas Plant Workers

Parameters (U/L)	20-30yrs (n=25)	31-40yrs (n=17)	41-50yrs (n=05)	51-60yrs (n=03)	F-value	P-value
AST	13.44±3.71^{a}	13.06±4.62^{a}	8.80±2.77^{b}	12.00±6.25^{ab}	1.833	0.154
ALT	6.32±3.50^{a}	7.12±3.50^{a}	5.80±2.77^{a}	5.33±2.52^{a}	0.397	0.755
ALP	29.68±8.05^{a}	31.29±7.01^{a}	27.20±8.76^{a}	36.67±5.77^{a}	1.105	0.292
GGT	111.07±89.43^{a}	89.73±55.73^{a}	47.54±20.41^{a}	87.20±51.03^{a}	1.132	0.346

Key: Values in a row with a different superscript are significantly different at p<0.05; n=Sample Size, P<0.05: Significant, P>0.05: Not significant, AST: Aspartate amino transferase, ALT: Alanine amino transferase, ALP: Alkaline phosphatase, GGT: Gamma glutamyl transferase.

On the contrary, this observation is not in agreement with the study of Viau (2012), who did not find significant effects on kidney function markers of refinery workers who were occupationally exposed to hydrocarbons, the major component of natural or LPG gas. When the population was separated into age groups, the findings showed that in all age groups, the mean values of Sodium, potassium, urea and creatinine varied across the age group. But however, there was significant increase in serum creatinine levels within the age group 41-50 years and 51-60 years. These observations in serum sodium, creatinine, urea and creatinine as regards the variations in the age groups and years of exposure were consistent with the findings of Ezejiofor *et al*., (2014).

The liver is involved in maintaining and regulating homeostasis and further plays a vital role in biochemical pathways necessary for growth and development (Ward, 1999). Hence, the maintenance of a healthy and functional liver is vital for the overall wellbeing of an individual. This study showed that the levels of AST, ALT, ALP and GGT were significantly higher in LPG plant workers when compared with the controls. This observation is in line with the work of Ezejiofor *et al*., (2014) where a similar trend of result was obtained. Other reports showed that long-term exposure to coke oven emissions increased the risk of liver dysfunction (Hu, 2010), while Wu (2012) and Chen (2006) explored the dose–response relationship between exposure to natural gas emissions in coke oven workers and reported a significant elevation of some liver enzymes in these workers that may have been related to their exposure to natural gas.

Abnormal liver functions with neurological symptoms were reported in individuals who had accidental inhalation of natural gas containing propane and butane (Pyatt, 1998). In addition, there are reports on the hepatotoxic and nephrotoxic effect of kerosene and petrol contaminated diets in Wistar albino rats (Patrick-Iwuanynwu, 2014) and this collaborates with the findings in this study. When the population was separated into age groups the findings showed that in all age groups, the mean values of AST, ALT, ALP and GGT varied across the age group. However, there was an increase in AST and GGT levels within the age group 20-30 years, ALT within 31-40 years and ALP within 51-60 years. This corroborates the reports of Mayne (1998) and Balisteri and Shaw (1999). Furthermore, the fact that there was consistently significant increase in values of liver enzymes clearly points to the existence of certain conditions among the LPG plant workers that does not obtain among the non LPG plant workers. Marked increase of the enzymes (10 to 100 times the upper limit of adult reference range) may be caused by circulatory failure with 'shock' and hypoxia, myocardial infarction (particularly for AST) and acute viral or toxic hepatitis, while moderate increase may be caused by Cirrhosis and– Malignant infiltration of the liver. GGT is an enzyme that transfers gamma-glutamyl functional groups. It is found in many tissues, the most notable one being the liver, and has significance in medicine as a diagnostic marker (Tate and Meister, 2005). Hence the significant increase in GGT level clearly points to the existence of liver dysfunction among LPG plant workers.

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Key Points

- This study revealed that there were significant increase in the values of sodium, creatinine, AST, ALT, ALP and GGT among the LPG plant workers as compared to the controls.
- Age comparison of renal function of LPG plant workers revealed significant increase in the level of serum creatinine within the age 41-50 years and 51-60 years while sodium, potassium, urea, AST, ALT, ALP and GGT levels were not significantly altered.
- The results of this study however showed that exposure to LPG resulted in significant alterations in renal and liver functions.

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