ORIGINAL ARTICLE

Biochemical and Haematological Assessment of Workers Exposed to Some Petroleum Products in Enugu Urban, Enugu State, Nigeria

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ABSTRACT

Background: *Exposure to petroleum product(s) occurs during extraction, refining, transportation and utilisation. Surprisingly, this relatively common hazard has received little public recognition. We therefore studied the adverse effects of petroleum products among occupationally exposed liquefied petroleum gas and histochemical workers in Enugu Urban, Nigeria.*

Methods: *Eight industries/departments were surveyed. Sixty workers were tested for some biochemical and haematological parameters (phosphatases, transaminases, complete blood count, erythrocyte sedimentation rate), were analysed, using standard methods. Also, 30 age and sex-matched apparently healthy subjects served as the control group.*

Results: *When the test and control results were compared, there were statistically significant differences ($p<0.05$) in: (1) haematocrit, reticulocytes, erythrocyte sedimentation rate, platelet, lymphocyte, monocyte, alkaline phosphatase, aspartate transaminase, alanine transaminase among liquefied petroleum gas workers and (2) haemoglobin, haematocrit, erythrocyte sedimentation rate, platelets, neutrophil, lymphocyte, monocytes, acid phosphatases and alkaline phosphatase among histochemical workers.. Overall, there was statistically significant decrease ($p<0.05$) in most of the parameters among the test subjects when compared with the control group. Blood films of the workers revealed mild to moderate hypochromia, anisocytosis and poikilocytosis while the controls were normocytic and normochromic.*

Conclusion: *We conclude that exposure to petroleum products adversely affects biochemical and haematological parameters. Hence, improved working conditions are recommended.*

KEYWORDS: *Biochemical; Haematological; Occupational exposure; Petroleum products.*

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INTRODUCTION

Exposure to petroleum product(s) occurs in many occupations, but the effect is not well recognised in most industries. As a result, medical practitioners fail to identify cases of petroleum product toxicity, and uninformed employers do not implement measures to control petroleum product exposure at the work site. Liquefied Petroleum Gas (LPG) and histochemical industries among others are common sources of exposure to petroleum products that have received little public recognition, especially in the developing countries like Nigeria. Petroleum products have become indispensable part of human life, sustaining activities and development, preventing and controlling many diseases, and increasing agricultural production. Despite their benefits, petroleum products may, especially when either misused, inhaled or exposed to living things at high dose, cause adverse effects on human health and environmental integrity[1,2]. The wide spread application of these products throughout the world increases the potential for adverse effects. The increase in demand and growth of petroleum/petrochemical industries, both in developed as well as developing countries is predicted to continue to increase[3-4]. Ideally, lessons learned in the developed world could help developing countries follow a more sustainable, less polluting path to industrialisation and modernisation. However, the available data suggested that the combined pressure of global competition and population increase leave little, if any room to manoeuvre in this respect[3]. Strikingly, there is scanty information on the effect of LPG (generally known as "cooking gas") and histochemical products such as alcohols, xylene, benzene and benzene derivatives, molten paraffin, formaldehyde, formalin, etc. (two of the most widely demanded of petroleum products) on blood (dyscrasias) and biochemical parameters among Caucasian LPG and histochemical workers[4]. Surprisingly, there appears to be none among Africans. Consequently, this appears to be the very first study on some biochemical and haematological values of LPG and histochemical workers in Enugu metropolis, Nigeria. Furthermore, it will be helpful to have more information on total human exposure particularly in developing countries[4], hence this study.

SUBJECTS, MATERIALS AND METHODS

Eight (8) LPG and histochemical industries located within Enugu urban were identified. Each work site was

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inspected, and the number of workers, the general working conditions and work practice, details of ventilation and duration of exposure were noted.

Each of the workers answered a short questionnaire about his job title, duration of exposure, past jobs, current tobacco sniffing and smoking habits, previous exposure to other petroleum product(s) and the presence or absence of symptoms of petroleum toxicity such as: dizziness, weakness, nausea, vomiting, irritation of the lungs, breathlessness and fatal cardio-respiratory failure due to pulmonary oedema.

Venous blood was withdrawn from consenting employees while at work. These subjects comprised of 49 males and 11 females aged 15-60 years with 6 months to 15 years of exposure. Also, 30 age and sex-matched apparently healthy subjects who were drawn from the same locality served as the control group. They were not exposed to any known air pollutants and were not tobacco smokers or sniffers.

Biochemical parameters: Phosphatases and transaminases were assayed by colorimetric method[5-7]. Haematological parameters, namely, haemoglobin (Hb), was assayed by the cyanmethaemoglobin method; packed cell volume (PCV) by microhaematocrit method; erythrocyte sedimentation rate (ESR) by the Westergreen method; total white blood cell (WBC) count by Turks method; differential leucocyte count was done by the battlement method, platelet count by the Cronkite manual method using 1% ammonium oxalate, and blood film by the push-wedge technique. Blood films were stained by Leishman's method for microscopic 200 cells differential leucocytes counts. Standard manual methods as described by Dacie and Lewis[8] were used for all haematological investigations. All blood samples were analysed within 30 minutes of blood collection.

RESULTS

Of the 10 industries contacted, 8 (80%) were surveyed. Two refused to participate in the study and gave the reason that they were not interested. The 8 participating industries/departments employed a total of 80 workers. Sixty of them (75%) participated in the study. Non-participating workers were not tested.

The industries were often small and poorly ventilated. Workers frequently ate, sniffed, and smoked tobacco in the working area. The work process was similar in all the industries. Workers never wore gloves, face-masks or respirators to protect themselves from the solution or gas in the cylinder. Exposure occurred predominantly during embalming or tissue processing for histochemical workers and transporting, emptying and refilling of gas cylinders for LPG workers, when petroleum gas (fumes) became airborne.

The results from the questionnaires revealed that, of the thirty (30) subjects studied in the LPG factories, 10 (33.33%) were cigarette smokers, 3 (10%) sniffed tobacco while 17 (56.67%) neither smoked nor took tobacco in any other form. Also, only 2 (6.67%) of the 30 histochemical workers smoked cigarette. None of the rest took tobacco in any other form (93.33%) Table I. Individuals handling histochemical compounds were predisposed to developing 'nose bleeding', especially tobacco sniffers.

All the subjects were either traders or school dropouts. Furthermore, 49 (81.67%) among the 60 subjects studied, complained of irritation of the eyes, while 41 (68.33%) complained of dizziness though most of them attributed this to low wages, late/non-payment of salaries, hard labour, malnutrition and socio-economic factors.

The result of these studies revealed that, there were statistically significant differences ($p<0.05$) in PCV, reticulocytes, platelet, total WBC, lymphocyte, monocyte counts, alkaline phosphatase, aspartate transaminase, alanine transminase among LPG workers, when compared with the controls. Also, there were statistically significant differences ($P<0.05$) in Hb, PCV, ESR, neutrophil, lymphocyte and monocyte counts and acid phosphatase (total and prostatic) between histochemical workers and the control group, (Tables II, III).

Tables IV and V show a comparison of haematological values of 30 LPG workers, 30 histochemical workers and 30 control subjects with respect to their duration of exposure to LPG and histochemicals respectively.

Furthermore, blood films of the workers revealed mild to moderate hypochromia, anisocytosis and poikilocytosis while the controls were normocytic and normochromic.

Table I. Represent Percentage Distribution of Tobacco Smokers, Sniffers, both Smokers and Non-Sniffers and, Non-Smokers and Sniffers and Symptoms of Petroleum Toxicity among the Study Group

(a) PERCENTAGE DISTRIBUTION OF TOBACCO USAGE

Departments	No of Subject Studied (N)	Cigarette Smokers (%)	Tobacco Sniffers (%)	Tobacco Smokers and Sniffers (%)	Non-Tobacco Smokers and Non Sniffers (%)
LPG	30	33.33	10	0	56.67
Histochemical	30	6.67	0	0	93.33

(b) SYMPTOMS OF PETROLEUM TOXICITY

SYMPTOMS	NUMBER	PERCENTAGE
Irritation of the eyes	49	81.67
Dizziness/Weakness	41	68.33
Nausea	0	0
Vomiting	0	0
Breathlessness	0	0

Table II. Comparison of Some Haematological Parameters Amongst LPG and Histochemical Workers and Controls

Parameter	LPG Workers Mean (SD) N = 30	Histochemcial Workers Mean (SD) N = 30	Control Mean (SD) N = 30
Hb (g/dl)	12.76 (1.72)*	12.47 (1.37) **	13.40 (1.43)
PCV (%)	38.33 (5.25)	37.93 (4.07)**	40.77 (4.70)
MCHC (g/dl)	33.34 (0.93)	32.94 (2.38)	32.92 (1.94)
Reticulocyte Count (%)	0.37 (0.53)*	0.37 (0.26)**	0.63 (0.45)
ESR (mm/hr)	11.33 (7.55)	26.13 (28.86)	17.37 (21.86)
Platelet (x10⁹/l)	203 (59.55)***	220 (116)**	280 (45.5)
Total WBC mm³ c.u.m.m	5200 (275)	529 (233)	4.73 (2.16)
Neutrophil (%)	51.20 (13.59)	46.00 (15.48)***	56.00 (9.21)
Lymphocyte (%)	44.70 (13.71)	52.43 (14.70)***	41.00 (10.96)
Eosinophil (%)	2.20 (2.33)	1.27 (3.07)	2.00 (1.79)
Basophil (%)	0.00 (0.00)	0.23 (0.50)	0.00 (0.00)
Monocyte (%)	0.47 (0.71)*	0.07 (0.25)***	1.00 (1.21)

P value compared to control groups; * P<0.05; **p<0.005; *** p<0.0005
N = Population studied; SD= Standard Deviation

Table III. Comparison of Some Biochemical Parameters Amongst LPG and Histochemical Workers and Controls

Parameter	LPG Workers Mean (SD) N = 30	Histochemcial Workers Mean (SD) N = 30	Control Mean (SD) N = 30
Alkaline Phosphatase (iu/l)	61.96 (30.53)***	57.08 (19.00)***	35.52 (15.05)
Aspartate transaminase (iu/l)	14.48 (6.94)**	13.24 (44.20)	10.65 (4.05)
Alanine transaminase (iu/l)	8.88 (4.88)*	9.20 (31.40)	7.21 (2.56)
Total acid phosphatase (iu/l)	4.27 (1.85)	4.44 (5.91)*	3.51 (0.85)
Prostatic acid phosphatase (iu/l)	0.80 (0.52)	1.14 (1.37)*	0.65 (0.25)

P value compared to control groups; * P<0.05; **p<0.005; *** p<0.0005
N = Population studied;
SD= Standard Deviation

Table IV. Comparison of Some Haematological Values of 30 Liquefied Petroleum Gas (LPG) Workers (Test) and 30 Non LPG Workers With Respect to their Duration of Exposure

Parameter	Duration of Exposure (years) < 6 years Mean (SD) N=25	Duration of Exposure (years) > 6 years Mean (SD) N=5	Control Mean (SD) N=30
Hb (g/dl)	12.74 (1.89)	13.10 (0.98)	13.40 (1.43)
PCV (%)	38.40 (7.40)	38.80 (2.65)	40.77 (4.70)
MCHC (g/dl)	33.27 (0.98)***	26.95 (7.64)	32.92 (1.94)
Reticulocyte Count (%)	0.35 (0.34)	0.26 (0.11)	0.63 (0.45)
ESR (mm/hr)	10.72 (19.14)	12.80 (10.70)	17.37 (21.86)
Platelet (x10⁹/l)	198.52 (60.61)	211.20 (44.45)	280 (45.5)
Total WBC mm³ c.u.m.m	5540 (3470)**	3780 (1840)	4.73 (2.16)
Neutrophil (%)	51.56 (12.66)	58.80 (20.63)	56.00 (9.21)
Lymphocyte (%)	45.52 (12.97)	40.00 (17.50)	41.00 (10.96)
Eosinophil (%)	2.29 (1.86)***	0.50 (1.80)	2.00 (1.79)
Basophil (%)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Monocyte (%)	0.40 (0.56)***	0.00 (0.00)	1.00 (1.21)

P value compared to control groups; * P<0.05; **p<0.005; *** p<0.0005
N = Population studied; SD= Standard Deviation

Table V. Comparison of Some Haematological Values of 30 Histochemical Workers and 30 Non Histochemical Workers with Respect to their Duration of Exposure

Parameter	< 6 years Mean (SD) N = 8	6-10 years Mean (SD) N = 4	11-15 years Mean (SD) N = 6	>15 years Mean (SD) N = 12	Control Mean (SD) N = 30
Hb (g/dl)	11.84 (1.67)**	11.51 (0.90)***	13.53 (0.90)	12.67 (1.16)*	13.40 (1.43)
PCV (%)	36.50 (5.90)	35.50 (3.00)**	39.00 (4.05)	39.17 (2.37)	40.77 (4.70)
MCHC (g/dl)	32.38 (1.55)	32.51 (2.46)	34.92 (3.26)	32.33 (2.06)	32.92 (1.94)
Reticulocyte (%)	0.50 (0.37)	0.43 (0.57)	0.81 (0.15)**	0.36 (0.19)	0.63 (0.45)
ESR (mm/hr)	31.63 (30.75)	51.25 (60.44)	19.67 (15.77)	17.33 (11.20)	17.37 (21.86)
Platelet (x10⁹/l)	239.00 (84.37)	155.00 (46.47)***	150.33 (25.43)***	263.00 (154.31)	280 (45.5)
Total WBC c.u.m.m	6375.00 (3326)	6600.00 (711.80)**	4200.00 (2395.83)	4666.67 (1407.34)	4.73 (2.16)
Neutrophil (%)	42.13 (16.23)*	52.00 (13.88)	46.33 (14.50)	46.42 (17.09)	56.00 (9.21)
Lymphocyte (%)	53.75 (13.70)*	47.25 (13.94)	53.67 (14.50)	52.67 (17.02)	41.00 (10.96)
Eosinophil (%)	3.75 (5.26)	0.00 (0.00)***	0.00 (0.00)***	0.67 (0.49)*	2.00 (1.79)
Basophil (%)	0.13 (0.35)	0.25 (0.50)	0.00 (0.00	0.00 (0.00)	0.00 (0.00)
Monocyte (%)	0.25 (0.46)*	0.50 (0.56)	0.00 (0.00)***	0.25 (0.62)*	1.00 (1.21)

P value compared to control groups; * P<0.05; **p<0.005; *** p<0.0005
N = Population studied; SD= Standard Deviation

DISCUSSION

This study has amply demonstrated that LPG and histochemical workers are exposed to occupational health hazards associated with both acute and chronic pollution from transportation, utilisation, emptying and refilling of cylinders and tanks with petroleum product(s). These results are similar to the findings obtained in other studies from individuals exposed to other contaminated environment[2,9]. However, only a few medical articles[10] specifically mention LPG and histochemical workers as being at high risk of petroleum product(s) exposure. Hence, it would be helpful to have more information on the total human exposure, particularly in developing countries[4].

The decreased red cell indices observed in this study appear attributable to prolonged exposure to some petroleum products as shown in tables IV and V.

Significant differences in biochemical and haematological parameters between the subjects and controls in the various study groups point to a relationship between biochemical and haematological values, nutritional status, socio-economic class and petroleum products. Furthermore, the values are within the normal range in the Nigerian community[11,12]. However the relationship between normal haematological values and values from workers in the petroleum products could not be compared with any previous findings in the Nigerian community since none appears to have been done to the best of our knowledge.

In addition, we examined specific factors associated with occupational health hazards from petroleum products and concluded that characteristics of work site related to exposure to petroleum products (fumes) are major contributors. Although, the role played by poor ventilation appeared not evaluated, the industries/departments were small and ventilation was inadequate; it would appear that poor surroundings might have negatively influenced the ventilation due to stuffy environment, hence increasing the amount of petroleum products inhaled. This could be worsened by the fact that the subjects did not use any protective device. However, we speculate that an increase in number of employees in some industries may have contributed to a slight reduction in some adverse effects because there were more opportunities for rotation in assignments other than handling petroleum products. Individual factors such as age, current tobacco sniffing and smoking habits, appeared less important in this study than factors in the work site.

The results of this investigation highlight several important public health issues. First, handling of petroleum products should be recognised as a common potential source of petroleum toxicity. Recognising and reducing source of petroleum exposure are important, given the consequences of acute and chronic intoxication, which include bone marrow suppression, nausea, breathlessness, irritation of the lungs, fatal cardio-vascular respiratory failure due to pulmonary oedema[13,14], and convulsion [15-17].

Furthermore, petroleum handling also presents a potential risk of poisoning to the children of workers[1]. However, petroleum toxicity among industrial workers, their families and the general public can be prevented by limiting exposure with the use of proper ventilation systems, improved house keeping and work practices, changes of clothing, and if indicated, appropriate and properly fitting respirators.

Finally, it illustrates the need for practitioners to take an occupational history in order not to miss or delay the diagnosis of work-related illnesses[18,19]. The limited recognition of work-related problems, particularly in developing countries should serve as an impetus for physicians to identify occupational illness in all their patients and to alert employers (or regulatory agencies, if necessary) about problems that might cause illness in other similarly exposed workers, so that corrective action can be taken. Thus, medical practitioners, employers, lawmakers, and the government can play an important and necessary part in preventing and reducing illnesses related to conditions in working places.

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