African Journal of Laboratory Haematology and Transfusion Science

Vol 2, Issue 2, page 123 -134 | June 2023 | www.ajlhtsonline.org
Article DOI: 10.59708/ajlhts.v2i2.2318
DOI Url: https://doi.org/10.59708/ajlhts.v2i2.2318

ORIGINAL ARTICLE

Full blood count and some haemorheologic variables of vendors exposed to liquefied petroleum (cooking) gas: a comparative study

Akpan, P. A.*, Okwara, C. C., Wonah, P. M.

Department of Haematology and Blood Transfusion Science, Faculty of Medical Laboratory Science, University of Calabar, Nigeria.

* Corresponding author: apu0520@unical.edu.ng; +2348027321305

Submitted: 21-03-2023
Accepted: 09-05-2023
Published: 30-06-2023

Abstract

Introduction: Cooking gas in the form of liquefied petroleum gas is sold in gas stations and outlets by vendors who do not use personal protective equipment despite working in a high-risk environment hence they have a high exposure to inhalation of the chemicals in the gas. This study assessed the full blood count and haemorheologic variables of vendors exposed to liquefied petroleum gas.

Methods: Forty gas vendors were enrolled from four gas stations in Calabar while forty apparently healthy individuals who do not work in gas-related jobs were recruited as control. Ethical approval was granted by the Cross River State Ministry of Health, Calabar. Permission to enroll workers was obtained from the management of gas stations while study subjects gave informed consent. A structured questionnaire was used to obtain demographic information and health history while blood pressure, weight and height were measured using standard instruments; the body mass index was calculated. The full blood count and haemorheologic variables were determined by standard methods. Data analysis was done using a student t-test on SPSS version 21 and a P value ≤0.05 was considered significant.

Results: The mean age was 25.9±3.2 years and 26.5±6.5 years for the test and control groups with gas vendors being predominantly males (97.5%). Work duration of 97.5% of gas vendors was ≤5 years. Sixty percent of the control and 42.5% of the gas vendors engaged in regular exercise while 40% and 57.5% do not. Sixty-seven-point five percent (67.5%) of the control rarely go for medical checks and 27.5% had never had a medical check with only 2% who check often. For the gas vendors, 55% have never had a medical check while 45% of them rarely check. Also, 42.5% of the control have never or rarely checked their blood pressure while 15% check often; 62.5% of the gas vendors have never checked their blood pressure while 37.5% rarely check. There was a family history of hypertension for 2 (5%) of the control and none for the test group. Also, 1 (2.5%) of the gas vendors had a history of fainting episodes while 39 of

them and the control did not. Only 10% and 20% of the gas vendors use nose mask and hand gloves with the use of overalls and safety boots being 40% for each. The body mass index of the control group (25.15kg/m^2) was not different (P>0.05) from that of the test group (24.53kg/m^2). Whereas the systolic blood pressure was higher for the gas vendors than the control (126.47mmHg and 120.32mmHg), the diastolic blood pressures were comparable (74.60mmHg versus 72.92mmHg). The full blood count shows the red blood cell count, haematocrit and haemoglobin of the gas vendors were significantly higher (P<0.05) than the control value while the mean corpuscular volume and mean corpuscular haemoglobin were comparable (P>0.05). Again, the mean corpuscular haemoglobin concentration and red cell distribution width standard deviation of the gas vendors were significantly higher (P<0.05) versus the control while the red cell distribution width coefficient of variation was comparable (P>0.05). The total white blood cell count and the absolute granulocyte and lymphocyte counts of the gas vendors were significantly higher (P<0.05) than the control value while the mixed leucocyte count was not different (P>0.05) between the two groups. The platelet count, mean platelet volume, platelet distribution width, platelet crit, platelet large cell ratio and platelet large cell count were significantly higher (P<0.05) for the gas vendors when compared to the control. Relative plasma viscosity and fibrinogen concentration were significantly higher (P=0.030) when the test group was compared to the control.

Conclusions: This study has demonstrated an increase in red cell, white cell and platelet parameters of vendors exposed to cooking gas as a probable response to an induced state of chronic inflammation. There is also impaired haemorheology as expressed by an increase in relative plasma viscosity and fibrinogen concentration with possible pre-disposition to cardiovascular disease as a consequence. Management of cooking gas stations and the vendors should be educated on the need to use personal protective equipment in order to reduce exposure to the components of cooking gas.

Keywords: Cooking gas, gas vendors, exposed, full blood count, Haemorheology

Introduction

Cooking gas is in the form of liquefied petroleum gas (LPG) which is a flammable mixture of hydrocarbon gases. most commonly propane, butane, and propylene. The LPG is used as fuel gas in heating appliances, cooking equipment, and vehicles. It is increasingly used as an aerosol propellant and a refrigerant, replacing chlorofluorocarbons in an effort to reduce damage to the ozone layer (1). Hydrocarbon gases are abundant in many products such as gasoline, motor oils, dry-cleaning solutions, and solvents which contain varying amounts and types

of materials, that are difficult to identify. In the case of intoxication, correct diagnosis is severely delayed in the absence of correct information about the product and the route of exposure. Butane is a major component of cooking gas making up 100% or 85%. It is commonly abused for its euphoric effect as it is easily obtainable in lighter refill cans and antiperspirants, and, therefore, is very popular among the youth (2). Inhaling butane can cause frequent ventricular fibrillation and subsequently lead to death. Propane is another component of cooking gas making up 15% in combination with butane; breathing in or swallowing propane can be harmful as it takes the place of oxygen in the lungs thus making breathing difficult or impossible.

Cooking gas is a global tool used for domestic work. It is sold in gas stations and outlets by vendors. It is observed that these gas vendors do not use personal protective equipment such as nose masks despite working in a high-risk environment hence they have a high exposure to inhalation of the hazardous chemicals in the gas. Constant inhalation of the components of cooking gas may affect blood parameters and the flow of blood may be obstructed. Indeed, inhalation of petroleum products such as fuel and LPG has been reported to alter haematological parameters for exposed workers in previous studies (3,4). Since blood acts as a pathological reflector of the status of exposed animals to toxicant and other conditions, haematological parameters are valuable in monitoring the health status of humans.This study seeks to add to the existing knowledge by assessing the full blood count and haemorheologic variables of vendors exposed to liquefied petroleum gas.

Materials and Methods

Study Design/Area

A cross-sectional design was used for this study. The study involved gas vendors in Calabar Metropolis. Calabar is the Cross River State's capital, located in Nigeria's South-South geopolitical zone.

Ethical considerations/informed consent

Ethical approval was obtained from the Ethical Committee of the Ministry of Health, Cross River State, and permission to conduct the research was obtained from the management of the gas stations involved. Informed consent was also obtained from all participants.

Subject selection

Subjects were enrolled in this study based on Convenience Sampling. A total of 80 male and female subjects were recruited for this study comprising of 40 apparently healthy gas vendors at SGL gas stations located at IBB road, Akim market, Marian market and Watt market, Calabar and 40 apparently healthy individuals who did not work with cooking gas or any other chemical to serve as the control group. Subjects who were ill and those who did not give their consent were excluded.

Sample Collection

A total of 5ml of blood was collected aseptically from a prominent vein; 3ml was dispensed into EDTA container to a final concentration of 2mg/ml for full blood count and relative plasma viscosity while 2ml was dispensed into 3.13% Trisodium Citrate container, which was spun and platelet poor plasma obtained for fibrinogen assay.

Sample analysis

Full blood count

Haematological parameters were determined using automated haematology analyzer (Abacus-580).

The principle depends on the fact that red cells are poor conductors of electricity while certain

diluents are good conductors. Blood is highly diluted in a buffered electrolyte solution. The flow rate of this diluted sample is controlled by the displacement of a tightly fitting piston. This results in a measured volume of the sample passing through an aperture tube of specific dimensions. By means of a constant source of electricity, a direct current is maintained between two electrodes, one in the sample beaker and the other in the aperture tube. As a blood cell is carried through the aperture, it displaces some of the conducting fluid and increases the electrical resistance. This produces a corresponding change in potential between the electrodes. The height of the pulses produced indicates the volume of the cells passing through. The pulses are led to a threshold circuit provided with an amplitude discriminator for selecting the pulse height which will be counted. The anti-coagulated sample was mixed properly by gentle inversion and 100µl was sucked into the machine through a probe. The blood was diluted and the various cell types were counted. The result was displayed on the computerized screen in standard units.

Relative Plasma Viscosity was determined by Reid and Ugwu's Method (5)

The principle is based on the ratio of the flow time for 1.0 ml of plasma to the flow time of the same volume of distilled water in a syringe viscometer held vertically in a retort stand, and is expressed as relative plasma viscosity (RPV).

The plasma viscosity was determined using a 1ml graduated syringe to which a hypodermic needle (21G 0.84 × 40 mm) was fitted and held vertically in a retort stand. The syringe viscometer was calibrated using distilled water. The plasma to be tested was drawn up taking care to exclude all air bubbles, into the vertical syringe until the end of the plunger passed the 1.0 ml mark. The plunger was then completely withdrawn and a stopwatch started as the lower meniscus of the fluid fell to the 1.0 ml mark. The time required for 1.0 ml of fluid to flow down the syringe was noted. As test of reproducibility of the method, ten observations were taken of the flow rate for distilled water. Plasma viscosity is expressed as relative viscosity which is the ratio of the flow time for 1.0 ml of plasma (Tp) to the flow time of the same volume of distilled water (Tn).

$$RPV = TP(s)/\ Tn(s)$$

Reference range: 1.47-1.86

Fibrinogen concentration was determined by Clauss Method (6) using kit purchased from Giesse Diagnostics, Italy.

Principle: When diluted plasma is clotted with excess of thrombin (~100u/ml), the fibrinogen level is inversely proportional to the clotting time.

The reagents were reconstituted according to the manufacturer's instructions. Serial dilutions of the fixed-value plasma were made and the clotting time of each dilution was recorded. A standard curve was plotted in a log-log grid with the concentration of the fixed value fibrinogen and its dilutions on the X-axis and the corresponding plotting times on the Y-axis. A 1 in 10 dilutions was made of the test plasma in the reagent buffer provided. 200 µl of diluted sample was incubated at 37^{o}C for 3 minutes; 100 µl of the FIB thrombin was added and a stopwatch started simultaneously. The clotting time was recorded. The fibrinogen concentration was read off the standard curve.

Reference Range: 200-400mg/dl (2.0-4.0 g/L)

Statistics

Results are presented as Mean $\pm$ Standard Deviation (S.D). Student t-test was used to compare means on Statistical Package for Social Sciences (SPSS) version 22. A p-value $\leq$ 0.05 was considered as significant.

Results

The full blood count and some haemorheologic variables of workers exposed to cooking gas were compared to an unexposed group (control) in this study. Table 1 presents the demographic data of the non-gas vendors and gas vendors. The mean age was 26.5±6.5 years for the control group and 25.9±3.2 years for the test group. Of the 40 gas vendors studied, 39 (97.5%) were males with only 1 (2.5%) females. The control was gender-matched to the test. Again, 39 (97.5%) of gas vendors had worked for a period of 1-5 years with only 1 (2.5) who had worked for more than 5 years. In response to the questionnaire administered, 24 (60%) of the control as well as 17 (42.5%) of the gas vendors engaged in regular exercise while 16 (40%) and 23 (57.5%) do not engage in regular exercise for the control and test groups respectively. Sixty-seven-point five percent (67.5%) of the control rarely go for medical checks and 27.5% had never had a medical check with only 2% who check often. For the gas vendors, 55% have never had a medical check while 45% of them rarely check. Also, 42.5% of the control have never or rarely checked their blood pressure while 15% check often; 62.5% of the gas vendors have never checked their blood pressure while 37.5% rarely check. There was a family history of hypertension for 2 (5%) of the control and none for the test group. Also, 1 (2.5%) of the gas vendors had a history of fainting episode while 39 of them and the control did not.

Figure 1 shows that only 10% of the 40 gas vendors use nose mask while working and hand (rubber) gloves was used by 20%. The use of overalls and safety boots was 40% for each. In figure 2, it is observed that the body mass index (BMI) of the control group (25.15kg/m^2) was not different (P>0.05) from that of the test group (24.53kg/m^2). Whereas the systolic blood pressure was higher for the gas vendors (126.47mmHg) when compared to the control (120.32mmHg), the diastolic blood pressures were comparable for both groups (74.60mmHg versus 72.92mmHg).

Table 2 shows the full blood count of non-gas vendors versus gas vendors. The red blood cell count (RBC) of the gas vendors was significantly higher (P=0.010) than the value for the control. Similarly, the haematocrit level (HCT) and haemoglobin concentration obtained for the gas vendors were significantly higher (P=0.010 and 0.001) than the value for the control. It was observed that the mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) of the gas vendors were comparable (P>0.05) to values obtained for the non-gas vendors. Conversely, the mean corpuscular haemoglobin concentration (MCHC) of the gas vendors was significantly higher (P=0.013) versus the control. While the red cell distribution width coefficient of variation (RDWCV) was comparable (P>0.05) between the test and control groups, the red cell distribution width standard deviation (RDWSD) was significantly higher (P=0.001) for the test versus the control. The total white blood cell count (WBC) of the gas vendors was significantly higher (P=0.010) than the control value. Similarly, the absolute granulocyte and lymphocyte counts obtained for the gas vendors were significantly higher (P=0.010 and 0.030) than the values for the control. The mixed leucocyte count was not different (P>0.05) between the two groups. The platelet count and mean platelet volume for the gas vendors were significantly higher (P=0.010 and 0.024) when compared to the values for the control. Both the platelet distribution width (PDW) and platelet crit (PCT) were significantly higher (P=0.025; P=0.010) for the test versus the control. Similarly, it was observed that the platelet large cell ratio (PLCR) and platelet large cell count (PLCC) were significantly higher (P=0.001) for the gas vendors when compared to values for the control.

In table 3, some haemorheologic variables of

vendors exposed to cooking gas is compared to that of non-gas vendors. The haematocrit value for gas vendors was significantly higher (P=0.010) than that obtained for the control. Similarly, the relative plasma viscosity for gas vendors was significantly higher (P=0.001) versus the control value. Again, the fibrinogen concentration was significantly higher (P=0.030) when the test group was compared to the control.

Table 1: Demographic data and health history of gas vendors and non-gas vendors

Parameters	**Gas Vendors (n=40)**	**Non-Gas Vendors (n=40)**
Mean age (years)	25.9 ± 3.2	26.5 ± 6.5
Gender		
Males n (%)	39 (97.5)	39 (97.5)
Females n (%)	1 (2.5)	1 (2.5)
Duration of Work as Gas vendor		
1-5 years n (%)	39 (97.5)	Nil
6-10 years n (%)	1 (2.5)	Nil
Voluntary Exercise		
Yes n (%)	17 (42.5)	24 (60.0)
No n (%)	23 (57.5)	16 (40.0)
General Medical Check		
Never n (%)	22 (55.0)	11 (27.5)
Rarely n (%)	18 (45.0)	27 (67.5)
Often n (%)	0 (0.0)	2 (5.0)
Blood Pressure Check		
Never n (%)	25 (62.5)	17 (42.5)
Rarely n (%)	15 (37.5)	17 (42.5)
Often n (%)	0 (0.0)	6 (15.0)
Family History of Hypertension		
Yes n (%)	0 (0.0)	2 (5.0)
No n (%)	40 (100.0)	38 (95.0)
History of Fainting		
Yes n (%)	1 (2.5)	0 (0.0)
No n (%)	39 (97.5)	40 (100.0)

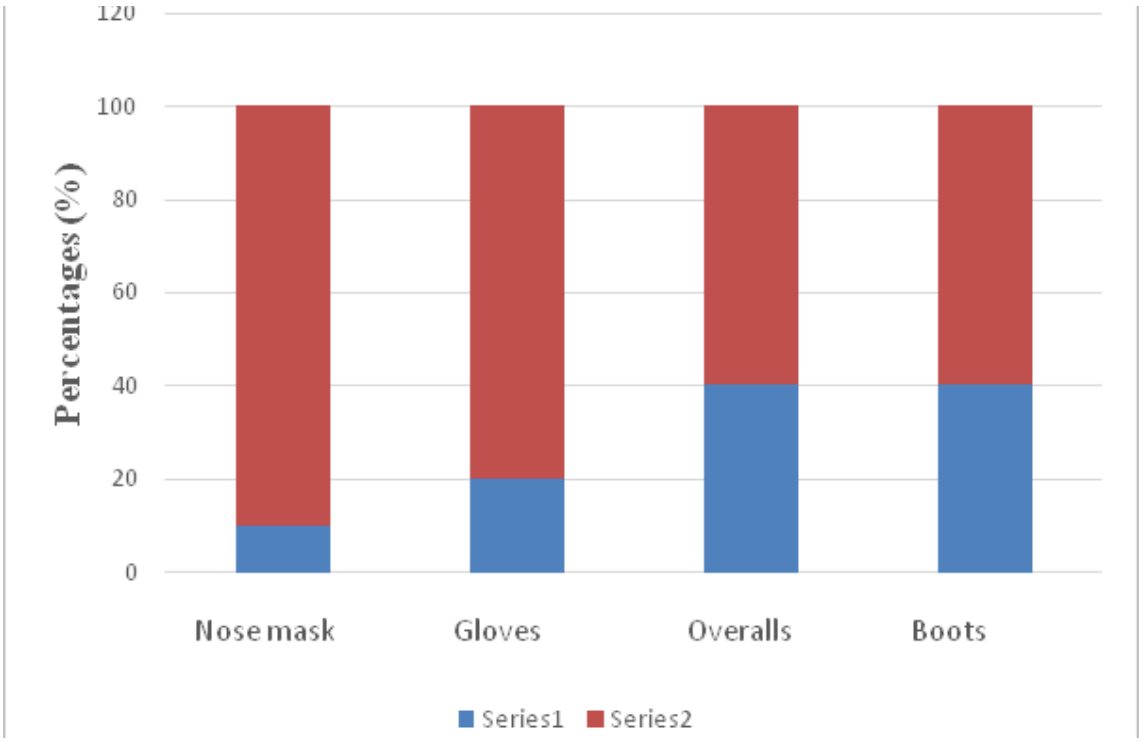

FIG. 1: Use of personal protective equipment by gas vendors
Series 1: Yes
Series 2: No

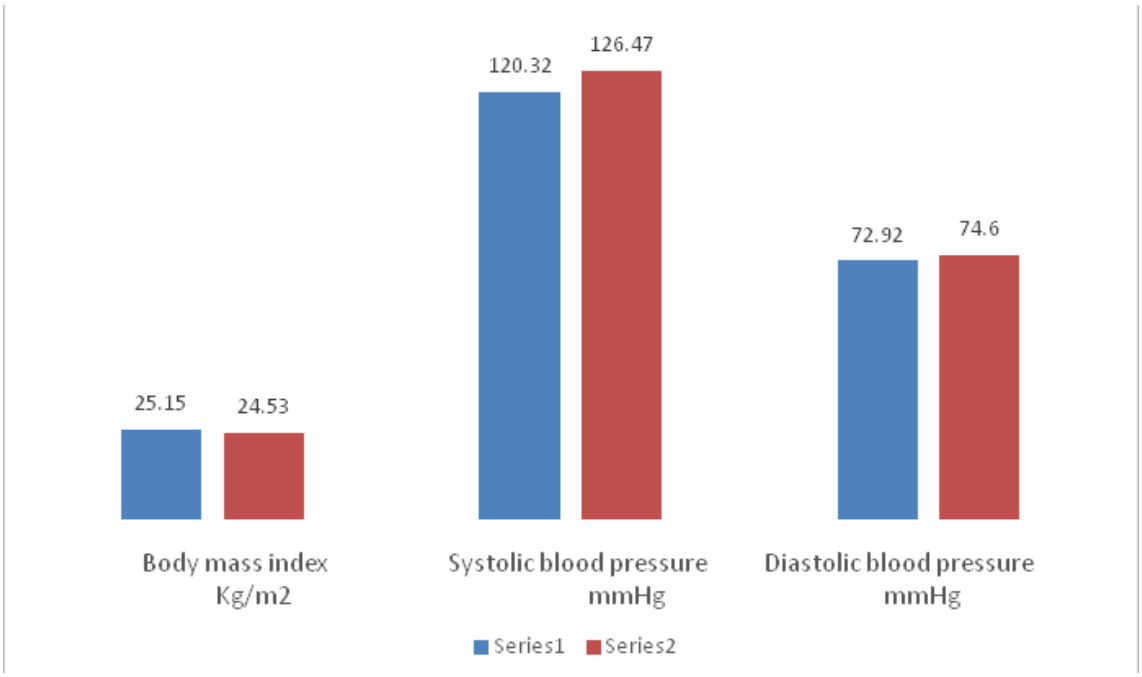

FIG. 2: Body mass index, systolic and diastolic blood pressures of non-gas and gas vendors
Series 1: Non-gas vendors
Series 2: Gas-vendors

TABLE 2: Full blood count of Gas Vendors versus Non-Gas Vendors

Parameters	Gas Vendors n=40	Non-Gas Vendors n=40	P-value
Red cell count (3.8-5.8 x 10^{12}/L)	5.47±1.00	4.93±0.70	0.010
Haematocrit (0.35-0.50L/L)	0.47±0.07	0.44±0.03	0.010
Haemoglobin (115-175g/L)	157.75±19.00	116.13±12.00	0.001
Mean corpuscular volume (80=95fl)	84.07±10.28	80.70±9.96	0.140
Mean corpuscular haemoglobin (27-34pg)	27.04±4.44	27.17±2.91	0.882
Mean corpuscular haemoglobin concentration (32-36 g/dl)	34.68±2.49	32.97±3.48	0.013
Red cell distribution width CV (11.5-14.5%)	14.18±1.09	14.27±1.03	0.697
Red cell distribution width SD (35-56fl)	42.68±2.61	30.23±8.75	0.001
Total white cell count (4-11 x 10^9/L)	9.72±2.65	4.35±1.67	0.010
Granulocytes (2-7.7 x 10^9/L)	5.09±2.43	2.70±1.80	0.010
Lymphocytes (0.8-5.5 x 10^9/L)	2.98±0.44	1.17±0.10	0.030
Mixed (0.1-1.0 x 10^9/L)	0.93±0.37	0.26±0.17	0.225
Platelet (125-350 x 10^9/L)	259.08±65.11	181.05±42.62	0.010
Mean platelet volume (7-11fl)	9.41±1.09	4.62±0.52	0.024
Platelet distribution width (9-57%)	20.34±2.36	11.79±1.43	0.025
Platelet crit (0.11-0.28%)	0.17±0.03	0.12±0.02	0.010
Platelet large cell ratio (11-45%)	25.12±3.49	17.04±6.19	0.001
Platelet large cell count (30-90%)	47.28±6.21	43.63±2.69	0.001

Table 3: Some haemorheologic variables of gas vendors and non-gas vendors

Variables	Gas Vendors (n=40)	Non-Gas Vendors (n=40)	P-value
Haematocrit (0.35-0.54 L/L)	0.47 ± 0.07	0.44 ± 0.03	0.010
Relative plasma viscosity (1.50-1.72)	2.07 ± 0.45	1.65 ± 0.26	0.001
Fibrinogen (200-400mg/dl)	250.16 ± 36.22	195.24 ± 35.81	0.030

Discussions

In this study, the full blood count and some haemorheologic variables of cooking gas vendors were assessed and compared to non-gas vendors (control). The mean age of the gas vendors shows that the occupation is most suited to young people. It was also observed that the male gender dominates this occupation. This is probably due to the aspect of lifting the gas cylinders which are very heavy and requires masculine strength. Another reason could be the long hours (up to 10 hours per day) put in by the gas vendors. Another observation is that most of the gas vendors had worked for one to five years with only 2.5% having worked longer than 5 years. This implies that gas vendors do not stay long on the job. Almost half of the control with more than half of the gas vendors do not engage in regular exercise showing that exercise is not a routine practice among the study population. Also, only 2% of the control do medical checks often with 55% of the gas vendors who have never had a routine medical check. A similar observation was made with regards to blood pressure checks; only few of the control check their blood pressures often with the majority of gas vendors having never checked their blood pressure. This implies that routine medical checks are not the general practice of the study population and could be due to lack of awareness and perhaps cost considerations. Indeed, the very few controls who practiced routine medical checks were those who had a family history of hypertension. However, there was no significant difference in the blood pressures and body mass index of gas vendors versus the control. The findings of this study revealed that only 10% of the gas vendors use nose masks while dispensing cooking gas with only 20% using rubber hand gloves; the use of overalls and safety boots was at 40%. This trend is worrisome considering that the contents of cooking gas include butane and propane, gases which when inhaled have been reported to cause myocardial infarction, ventricular fibrillation and cardiac arrhythmia with fatal outcomes (2,7). Another study also reported permanent and severe brain damage in addition to ventricular fibrillation and cardiac arrest as a consequence of butane inhalation (8). In fact, there are reports of intentional inhalation of liquefied petroleum gas for the purpose of committing suicide as it is known to result in death. Those who survive butane and propane toxicity have been known to develop ataxia and Parkinson's (9). The implication of this should be considered for the gas vendors in this study who work without protection against inhalation.

This study reported higher values of red blood cell count, haematocrit and haemoglobin for the gas vendors although these values are all within the reference range. Normal haemoglobin and complete blood counts have been reported in cases of butane toxicity (10,8) while another study reported significantly higher values for RBC, Hb, HCT, MCH and MCHC (4). In contrast, significantly lower values were reported for RBC, Hb, and HCT for workers exposed to gasoline in Ethiopia (11). The mechanism of increase in red cell parameters as observed in this study, could be that inhalation of butane and propane displaces oxygen thereby causing hypoxia which is a known stimulator for increased erythropoiesis (12). The total white cell, granulocyte and lymphocyte counts of workers exposed to cooking gas were higher versus the control although the values were all within the reference range. Increase in white cell counts has been reported previously for children exposed to gas cooking with the values still within the reference range (13) although there is a contradictory report of lower WBC in another study involving adults who were LPG-exposed workers (4). One possible explanation for increase in white cell counts is that inhalation of cooking gas over a prolonged period may induce a state of chronic inflammation which causes increased production and mobilization of white blood

cells.

The platelet count was found to be significantly higher for workers exposed to LPG in this study. A similar finding has been reported (4). The increase in platelet numbers suggests an increase in megakaryocyte production; however, there is no report in the literature linking exposure to cooking gas with increased platelet production. Again, a state of chronic inflammation as may be induced by long-term exposure to butane and propane in liquefied petroleum gas could be the reason for the increase in platelet numbers as platelets have been reported to participate in the inflammatory response (14,15). The mean platelet volume was found to be higher for gas vendors. On the other hand, the platelet distribution width was significantly higher for gas vendors versus the control although the values were within the reference range. An increase in platelet distribution width suggests variation in the size of platelets, a finding which has been associated with cardiovascular disease and conditions of increased platelet activation (16,17). A higher platelet crit observed for gas vendors also suggests the presence of inflammation as was reported for hepatitis A infection (18). The platelet large cell ratio and large cell count are higher for gas vendors than for non-gas vendors. Higher values of these platelet indices are associated with platelet activation which is seen in inflammatory states and is also linked to cardiovascular diseases (19). An increase in platelet numbers as well as platelet indices as observed for the gas vendors implies that there is an ongoing activation of platelets which is a marker for the presence of chronic inflammation.

Relative plasma viscosity and fibrinogen concentration were observed to be significantly higher for workers exposed to cooking gas versus the control. These variables are useful in the determination of haemorheology or blood flow properties. Fibrinogen is an acute-phase reactant and its levels increase in inflammatory states. Exposure to the components of cooking gas has been linked to the inducement of an inflammatory state (15) which could explain the increase in fibrinogen concentration. An increase in relative plasma viscosity is an indication that the blood is more viscous and blood viscosity is directly influenced by the haematocrit and concentrations of plasma proteins including fibrinogen. Increased blood viscosity as observed for the gas vendors in this study, is a risk factor for the development of cardiovascular and cerebrovascular disease with associated morbidity and mortality (20,21).

Conclusions

This study has demonstrated an increase in red cell, white cell and platelet parameters of vendors exposed to cooking gas as a probable response to an induced state of chronic inflammation. There is also impaired haemorheology as expressed by an increase in relative plasma viscosity and fibrinogen concentration with possible pre-disposition to cardiovascular disease as a consequence. Management of cooking gas stations and the vendors should be educated on the need to use personal protective equipment in order to reduce exposure to the components of cooking gas.

Acknowledgements

The authors wish to appreciate the Management of Gas Stations who gave permission and access to their staff and all the subjects who consented to participate in this study.

References

1. Encyclopaedia Britannica. Liquefied petroleum gas Retrieved from Britannica .com on 12th March, 2023.
2. Sen A, Erdivanli B. Cardiac arrest following butane inhalation Anesthesia: Essays and Researches 2015; 9, 273-275.
3. Okoro A M, Ani E J, Ibu J O, Akpogomeh B A. Effect of petroleum products inhalation on some haematological indices of fuel attendants in Calabar Metropolis, Nigeria Nigerian Journal of Physiological Sciences 2006; 21(1-2), 71-75.
4. Sirdah M M, Al Laham N A, El Madhoun R A. Possible health effects of liquefied petroleum gas on workers at filling and distribution stations of Gaza Governorates Eastern Mediterranean Health Journal, 2013;19(3), 289–294.
5. Reid H L, Ugwu A C. A sample technique for rapid determination of plasma viscosity. Nigerian Journal of Physiological Science, 1987; 3, 45-48.
6. Clauss A. Rapid physiological coagulation method for the determination of fibrinogen. Acta Haematology 1999; 17, 37-46.
7. Khalid N A. Fatal butane toxicity and delayed onset of refractory ventricular fibrillation Saudi Medical Journal 2017; 38(12), 1250-1254.
8. Tahir A, Pokorny P, Malek N. Butane toxicity: The curse of volatile solvent abuse Dubai Medical Journal 2021
9. Godani M, Canavese F, Migliorini S, Del Sette M. Ataxia with Parkinsonism and dystonia after intentional inhalation of liquefied petroleum gas Neuropsychiatric Disease and Treatment 2015; 11,1157-1159.
10. Abdulaziz A A, Abdulmalik M A, Afnan A A. Cardiac arrest due to butane gas inhalationin an 18 years old boy CaseReports in Emergency Medicine 2019; 2461346, 3pp.
11. Teklu G, Negash M, Asefaw T, Tesfay F, Gebremariam G, Teklehaimanot G. et al. Effect of gasoline exposure on hematological parameters of gas station workers in Mekelle City, Tigray Region, Northern Ethiopia Journal of Blood Medicine 2021; 12, 839-847.
12. Haase V H. Regulation of erythropoiesis by hypoxia-inducible factors Blood Reviews 2013; 27(1), 41-53.
13. Holscher B, Heinrich J, Jacob B, Ritz B, Wichman H E. Gas cooking, respiratory health and white blood cell counts in children International Journal of Hygiene and Environmental Health 2000; 203(1), 29-37.
14. Morrel C N, Aggrey A A, Chapman L M, Modjeski K L. Emerging roles of platelets as immune and inflammatory cells Blood 2014; 123(18), 2756-2767.
15. Sonmez O, Sonmez M. Role of platelets in immune system and inflammation Porto Biomedical Journal 2017; 2(6), 311-314.
16. Vagdatli E, Gounari E, Lazaridou E, Katsibourlia E, Tsikopoulou F, Labrianou I. Platelet Distribution Width: a simple, practical and specific marker of activation of coagulation Hippokratia 2010; 14(1), 28-32.
17. Li T, Jin J, Meng Z, Zhang W, Li Y, Yu X. et al. The different associations between platelet distribution width and hypertension subtypes in males and females Bioscience Reports 2020; 40(11), BSR20201747.
18. Coksun M E, Alidris A, Temel M T, Akbayram S, Hizli S. Plateletcrit: A possible biomarker of inflammation in hepatitis A infection Nigerian Journal of Clinical Practice 2019; 22(5), 727-730.
19. Gawlita M, Wasilewski J, Osadnik T, Regula R., Bujak K, Gonera M.

Mean platelet volume and platelet-large cell ratio as prognostic factors for coronary artery disease and myocardial infarction Folia Cardiologica 2016; 10(6), 418-422.

20. Akpan P A, Akpotuzor J O, Emeribe A O. Haemorheologic and fibrinolytic activities of pulmonary tuberculosis patients in Calabar, Cross River State, Nigeria. Journal of Medical Laboratory Science 2011; 20 (1), 27-32.

21. Klabunde R E. Viscosity of Blood in Cardiovascular Physiology Concepts 2022 Retrieved 8th March 2023 from www.cvphysiology.com

How to cite this article. Akpan, PA., Okwara,CC., Wonah, PM. Full blood count and some haemorheologic variables of vendors exposed to liquefied petroleum (cooking) gas: a comparative study. Afr J Lab Haem Transf Science 2023;2(2): 123 - 134.
DOI: https://doi.org/10.59708/ajlhts.v2i2.2318