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Assessment on the Effect of Smoke Residues on Fish Grillers In Mammy Market Mogadishu Cantonment, Abuja

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Abstract

Background: *Fish grilling by using charcoal emits toxic gaseous substances that can have short-term or long-term effects on human systems. Other studies separately on Biochemical and haematological parameters reported that exposure to some air pollutants during fish grilling can be injurious to humans. This study investigated the effect of smoke residues on fish grillers in mammy market of Mogadishu cantonment, Abuja, Nigeria.*

Material and methods: *The subject of this study were 95 that composed of 75 fish grillers as test groups and 20 non-fish grillers but doing other occupations within the market as control groups. Demographic data were obtained from them using a structured questionaire. The biochemical parameters were assayed using Selectra Pro S automated chemistry analyser while that of haematology was Sysmex KX-21N three parts analyser.*

Results: *This research finding showed that exposure to charcoal smoke is associated with significant alterations in HDL and LDL especially in longer exposure (Table 2). They are at high risk of developing coronary heart diseases. There is a significant increase in total protein and GGT. GGT is an indicator of early liver cell damage or cholestestatic disease. Serum level of GGT is commonly elevated in patients with acute hepatitis although the rise in GGT is usually less than that of transaminases. This research work showed statistically significant increase in serum GGT ($P>0.05$) among the test group in Table 3 as the duration of exposure increases.*

Increase in the value of absolute lymphocytes mixed cells associated with significant increase in Hb, WBC, MCV, MCH, MCHC, platelets, RDW and differential neutrophils values in Table 5 is caused by exposure to hazardous chemicals contained in grilled fish smoke which have the potential to lead to health problems and disease progression.

Conclusion: *This research has succeeded in showing the effect of air pollution originating from smoked fish processing by grilling. Exposure to charcoal smoke is associated with significant alterations in HDL, Triglycerides, LDL among test group (Table 2) especially as the duration of the exposure increases (Table 3). The research subjects are at high risk of developing coronary heart diseases. GGT is an indicator of early liver cell damage or cholestestatic disease. Serum level of GGT is commonly elevated in patients with acute hepatitis although the rise in GGT is usually less than that of transaminases. The research has succeeded in showing the impact of air pollution originating from smoked fish processing by grilling. Increase in the value of lymphocytes and mixed cells accompanied by the increase of Hb, WBC, MCV, MCH, MCHC, platelets, RDW and differential neutrophils values is caused by exposure to hazardous chemicals contained in grilled fish smoke which have the potential to lead to health problems and disease progression. Research similar to different observed parameters must be carried out in order to ascertain the effects of exposure to air pollutants especially in larger sample quantities.*

Keywords: *Grilled fish sellers, biochemical parameters, haematological parameters, polycyclic aromatic hydrocarbons, particulate matter*

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I. Introduction

Cooking is an art, technology and science of preparing food for consumption (Wong, 2021).Cooking techniques and ingredients vary widely across the world, such as grilling, baking using various types of implements and also reflecting unique environmental, economic and cultural traditions and innovations(Silva *et* *al*., 2016). Different techniques and training determines the quality of food prepared. Cooking is done for the family, commercial purposes or for a particular occasion(McGowan *et al.,* 2017).

The most common method of cooking food to humans is its preparation with heat or fire. It may have started several years ago, though ancient evidence for it reaches no more than 1 million years ago(Akbar *et al*., 2011).

With the large diversity in agriculture, culture, commerce, trade, and transportation across region in the globe regions led to the discovery of different types of ingredients. New inventions and technologies, such as the invention of pottery for holding and boiling water, expanded cooking techniques. Modern cooking techniques involved the application of advanced scientific techniques for food processing to give additional flavour that is desired(Gibbs and Myhrvold, 2011).

Grilling is a type of cooking that requires the application dry heat on the surface of food, commonly on the top, underneath or by the side(Sandra Bastin, 2011). It usually involves a significant amount of direct, radiant heat, and tends to be used for cooking meat and vegetables quickly(de Assumpção *et al.,* 2020).

In Nigeria, Grilled fish is a very popular food especially in Abuja. It is prepared on a charcoal or coals, which gives it additional flavour, attractive colour and sweet aroma (Raji *et al*., 2017).Grilled food using wood charcoal can emit smoke residues such as particulate matter (PM), carbon (ii) oxide (CO), polycyclic aromatic hydrocarbons (PAHs), nitrogen oxides (NO), Sulphur dioxide, volatile organic compounds, heavy metals (Fluoride, Arsenic, Lead, Mercury and Selenium) and other toxic compounds. These could consequently be responsible for short-term and long-term effects on human health (Olujimi *et al*., 2016). Atmospheric Pollutants can be significantly increased as a result of the smoke produced during the grilling process. They are known to cause adverse health effects on human body by interacting with molecules that are key for the biochemical or physiological processes (Rengarajan *et al*., 2015). Exposure to biomass burning smoke has been shown to have a detrimental effect on cardiovascular health (Rahman *et al*,2017).

The most abundant emission substances produced during food processing using charcoal is Carbon (ii) oxide (Djenane and Roncalés, 2018). In addition, carbon (ii) oxide can also be produced from motor vehicle emissions, smoking and other household appliances that use fuel (Reşitoꞁlu *et al.*, 2015). Exposure to carbon (ii) oxide can replace oxygen to bind to haemoglobin (Hb), which results in a reduced amount of oxygen in the body (hypoxia) which can affect the biochemical processes in the body (Collins *et al*., 2015). This exposure can cause tissue hypoxia and can stimulate the formation of red blood cells (RBC) and haemoglobin (Hb) (Metere *et al.*, 2014).

The soluble fractions of charcoal smoke is able to cross to the extra-pulmonary circulations thereby increasing the chance to harm extra-pulmonary organs including the kidney, liver and heart (Djenane and Roncalés, 2018) and (Reşitoꞁlu *et al*., 2015). The second most abundant pollutant resulting from grilling fish using charcoal is particulate matter. Particulate matter has been declared carcinogenic by the International Agency for Research on Cancer, including emissions from household fuels such as wood and charcoal (Visani *et al*., 2015). Particulate matter exposure can induce the production of reactive oxygen species (ROS) which can activate pro-inflammatory and pro-thrombotic pathways, produce endothelial dysfunction, increase blood coagulation and the development of cardiovascular disease (Hamanaka and Mutlu, 2018).

Hazardous emissions that are also produced are polycyclic aromatic hydrocarbons which are genotoxic and contain carcinogenic compounds for humans (Olujimi *et al*., 2016). Polycyclic aromatic hydrocarbons can further induce haemolytic anaemia (Troisi *et al*., 2007). The content of heavy metals in grilling smoke can produce free radicals that cause oxidative stress in living cells and induce an inflammatory response (Birben *et al*., 2012).A complete blood count is one of the easy screening methods to find out the hematotoxicity of pollutants in the air (Mistry *et al*,2016). Research shows a relationship between haematological parameters and exposure to air pollution, although the results obtained are still not consistent. Air pollutants, especially particulate matter, have a significantly negative correlation with Hb and RBC, and a significant positive relationship with white blood cells (WBC) and platelet counts (Poursafa *et al*., 2011). In 2012, a study reported by the Central Pollution Control Board for healthy adult individuals in Delhi who were exposed to air pollution showed an increase in Hb, haematocrit (HCT), RBC, WBC, monocytes, basophils and platelets levels (Central Pollution Control Board Ministry of Environment and Forests, 2008). Haemoglobin and RBC levels in individuals exposed to CO have also been reported to increase (Metere *et al*., 2014).

The relationship between exposures to air pollutants with haematological parameters is still controversial, and there have not been many specific investigations for pollutants produced by charcoal. This study aimed to carry out haematological analysis including Hb, RBC, HCT, mean cell volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), WBC, lymphocytes, neutrophils, mixed cells, red cell distribution width (RDW) and thrombocytes in individuals exposed to air pollutants from smoked grilled fish using charcoal (Purbayanti *et al*., 2020).

This study is designed to assess the possible association of smoke from charcoal on haemato-biochemical markers on exposure among fish grillers at Mammy market of Mogadishu cantonment Abuja.

Research subjects, materials and methods

The subjects recruited in this study were 95 consented participants. Total of 75 were women fish grillers exposed to the smoke while 20 control groups who are not exposed to the smoke but were into other occupations within the Mammy market of Mogadishu cantonment Abuja.

The inclusion criteria participants were between the ages of 15 years and above, who were apparently healthy and don't have the history of chronic diseases, smoking, consuming alcohol, drugs or vitamins that could affect the number of blood cells, liver and kidney.

The test groups were determined based on information obtained through structured questionnaires, which contained participants' identity, work history, medical history, smoking habits, alcohol consumption and drugs or vitamins commonly consumed. Individuals who meet the criteria were asked to fill informed consent forms for blood sampling.

Sample collection

5 ml blood sample from the cubital fossa (vein) of the subjects was taken in the morning between 8 to 10 a.m. using vacutainer syringe/needle and sample bottles. The 5 ml purple top bottle containing tri potassium ethylene diamine tetra acetic acid (K_3 EDTA) anticoagulant were for haematology sample, red top plain container and grey top containing Sodium fluoride/sodium oxalate anticoagulant for other biochemical parameters and glucose respectively.

Haematology samples were sent to the laboratory within 1 hour of collection for analysis, while Biochemistry samples were allowed to stand for 30 minutes, and then centrifuged at 3,500 rpm for 10 minutes. The supernatant (Serum and plasma) were separated and transferred into an appropriately labelled plain sample tubes and analysed.

Biochemical parameters examination

All biochemical parameters were assayed using Selectra Pro S Automated chemistry analyser. The equipment was manufactured by Elitec Group vital scientific, Van Rensselaergweg, Netherlands. The parameters assayed were: Liver profile (Alanine Aminotransferase, Aspartate Aminotransferase, Bilirubin (Direct and Total), Albumin, Gamma GT, Total protein and globulin), Lipid profile (Total cholesterol, High density lipoprotein, Low density Lipoprotein and triglycerides), Kidney profile (Urea, Creatinine, Uric acid, sodium, potassium and chloride) and glucose level. Quality control will be performed using two levels of controls (Control I and II). All reagents were ready to use and didn't require any preparation.

Haematological examination

Haematological parameters were assayed using Sysmex KX-21N 3 part automated haematology analyser, it was manufactured by Sysmex corporation Kobe, Japan. It was used to assay all haematological parameters consisting of White blood cell count (WBC), Red blood cell count (RBC), haematocrit count (HCT), haemoglobin count (Hb), mixed cells (monocytes, basophils and eosinophils), platelets counts, mean cell volume (MCV), mean corpuscular haemoglobin concentration (MCHC), mean corpuscular haemoglobin (MCH), and Red cell distribution width (RDW). Quality control check was performed using Low, normal and high levels of control. All reagents were ready for use without the requirement of any preparation.

Data analysis

The data obtained were recorded in Microsoft Excel Spreadsheet 2019, analysed using t-test and one way analysis of variance in IBM SPSS version 23.0 to obtain the means and standard deviations of both the test and control groups. The level of significance between the test and control groups was set at $P<0.05$ in 95 % confidence interval.

Ethical clearance

This dissertation proposal was submitted to the ethical committee of the Ministry of Defence Headquarters, Abuja ethical committee where it was reviewed and approved with reference number MODHREC/APP./014161/1/71018/20/2101 dated NHREC/28/01/2020B.

II. Results

Table 1.Shows the age and duration of exposure of the research participants according to test and control groups. The mean age in years and standard deviation of the test group was (32.25 ± 6.3) with majority in the age group of 26 to 35[38(50.6 %)] so also the same age group with the control [7(35.0 %)]. Total of 33(44.0 %) of the test participants and 12 (60.0%) of the Control group have Ordinary (O) level education. Their duration of exposure was also characterised into different strata, those exposed from 1 to 5 years are 26 (34.6 %) while those exposed between years 6 to 10 have the lowest number in the categories

Table 1: Age and duration of exposure of the participants according to test and control groups.

Parameter	Test (n=75)	Control (n=20)
Age (Years)	32.3 ± 6.3	32.0 ± 9.6
15 – 25	9 (12.0 %)	5 (25 %)
26 – 35	38 (50.6 %)	7 (35 %)
36 – 45	21 (28.0 %)	5 (25 %)
46 Above	7 (9.3%)	3 (15 %)
Level of Education		
Higher Degree	0 (0.0 %)	0 (0.0 %)
Degree	0 (0.0 %)	2 (10.0 %)
Diploma	0 (0.0 %)	3 (15.0 %)
'O' Level	33 (44.0 %)	12 (60.0 %)
Primary School	37 (49.3 %)	3 (15.0 %)
None	5 (6.6 %)	0 (0.0 %)
Duration of Exposure (Years)		
1 – 5	26 (34.6%)	-
6 – 10	14 (18.6%)	-
11 – 15	12 (16.0%)	-
16 and Above	23 (30.6%)	-

Table 2: This is a presentation of the effect of smoke residues on biochemical parameters. The results revealed a significant (P<0.05) increase in mean Albumin among the test groups compared to the control group.

Table 2: Effect of smoke residues on the biochemical parameters of all the participants

Parameter	Test (n=75) Mean ± SD	Control (n=20) Mean ± SD	P-value
Liver Function Tests			
ALT (U/L)	25.7 ± 10.6	20.6 ± 9.4	0.39
AST (U/L)	43.5 ± 13.2	23.9 ± 15.3	0.66
Total Bilirubin (µ/l)	8.5 ± 5.6	7.6 ± 5.6	0.27
Direct Bilirubin (µ/l)	3.6 ± 1.4	3.1 ± 2.0	0.32
Indirect Bilirubin (µ/l)	5.3 ± 4.9	4.5 ± 5.2	0.42
Total Protein (g/l)	77.6 ± 4.4	69.3 ± 5.8	0.24
Albumin (g/l)	46.9 ± 3.2	37.6 ± 3.2	**0.00**
Globulin (g/l)	33.5 ± 0.3	31.5 ± 0.9	0.58
GGT (U/L)	58.5 ± 4.2	45.1 ± 4.7	0.44
Lipid profile			

Total Cholesterol (mmol/l)	5.40 ± 0.8	4.70 ± 1.4	0.55
HDL (mmol/l)	1.90 ± 0.2	0.90 ± 1.5	0.49
Triglycerides (mmol/l)	1.46 ± 0.7	1.40 ± 1.8	0.82
LDL (mmol/)	3.57 ± 0.8	2.60 ± 1.7	0.20
Renal Function test			
Sodium (mmol/l)	143.4 ± 7.5	137.8 ± 6.5	0.09
Potassium (mmol/l)	4.7 ± 0.8	4.4 ± 1.2	0.20
Chloride (mmol/l)	103.9 ± 3.1	93.1 ± 6.5	0.17
Urea (mmol/l)	4.5 ± 1.1	4.0 ± 1.3	0.25
Creatinine (mmol/l)	84.7 ± 18.2	68.8 ± 36.4	0.95
Uric Acid (µmol/l)	278.6 ± 81.5	269.2 ± 107.2	0.13
Others			
Glucose (mmo/l)	5.6 ± 1.1	5.7 ± 1.3	0.31

ABBREVIATIONS: ALT- Alanine transaminase, AST- Aspartate transaminase, GGT- Gamma Glutamyl transaminase, HDL- High density lipoprotein, LDL-Low density lipoprotein and SD-Standard Deviation. Results are presented in mean ± standard deviations for both test and control, all taken at P<0.05 level of significance. Significant P-values (P<00.5) are in bold.

Table 3: As presented in Table 3, the mean Total protein, Total bilirubin, Gamma GT, Triglycerides and Uric Acid concentration were significantly (P<0.05) higher among the test participants exposed to smoke on the duration above 16 years.

Table 3: Biochemical parameters of all the participants according to various duration of exposure

Parameter (years)	1-5 (n=29) Mean ± SD	6–10 (n=20) Mean ± SD	11–15(n=18) Mean ± SD	>16(n=8) Mean ± SD	P-value
Liver Function Tests					
ALT (U/L)	25.0 ± 7.9	23.9 ± 9.6	23.0 ± 6.6	22.8 ± 12.0	0.52
AST (U/L)	39.7 ± 9.5	43.1 ± 14.3	43.6 ± 7.4	46.9 ± 5.9	0.32
Total Protein (g/l)	75.2 ± 3.9	74.6 ± 5.6	76.3 ± 2.6	79.4 ± 1.7	**0.02**
Albumin (g/l)	45.3 ± 1.6	45.8 ± 1.6	46.1 ± 2.6	46.8 ± 1.7	0.44
Globulin (g/l)	32.6 ± 3.9	33.9 ± 10.9	33.5 ± 4.2	31.3 ± 4.9	0.29
T. Bil.(µmol/l)	8.6 ± 3.8	7.3 ± 3.6	9.1 ± 2.7	10.2 ± 2.9	**0.03**
D. Bil.(µmol/l)	3.3 ± 0.9	3.1 ± 1.0	3.5 ± 1.2	3.8 ± 0.9	0.07
Ind. Bil.(µmol/l)	5.2 ± 2.6	5.4 ± 2.2	6.0 ± 2.8	4.8 ± 0.7	0.06
GGT (U/L)	43.6 ± 16.0	45.8 ± 23.0	46.4 ± 11.3	60.3 ± 12.4	**0.04**
Lipid Profile					
T.Chol. (mmol/l)	4.51 ± 0.9	4.89 ± 0.8	5.03 ± 0.7	5.23 ± 1.0	0.06
HDL (mmol/l)	1.89 ± 0.5	1.88 ± 0.6	1.89 ± 0.2	2.00 ± 1.0	0.66
Triglycerides (mmol/l)	1.11 ± 0.3	1.26 ± 0.4	1.31 ± 0.6	1.42 ± 0.6	**0.01**
LDL (mmol/l)	3.31 ± 0.7	3.18 ± 0.6	3.40 ± 0.8	3.61 ± 0.6	0.05
Renal Function Tests					
Sodium (mmol/l)	140.7 ± 5.8	142 ± 8.8	143.6 ± 5.4	144.7 ± 2.8	0.42
Potassium (mmol/l)	4.6 ± 0.6	4.7 ± 0.9	4.8 ± 0.6	4.5 ± 0.5	0.34
Chloride (mmol/l)	98.4 ± 3.7	99.2 ± 3.6	104.9 ± 4.2	102.7 ± 3.8	0.25
Urea (mmol/l)	4.3 ± 1.3	4.1 ± 1.2	4.3 ± 1.0	5.9 ± 0.6	0.60
Creatinine (µmol/l)	74.6 ± 11.3	76.1 ± 7.6	79.8 ± 9.6	94.7 ± 23.0	0.29
Uric Acid (µmol/l)	252.8 ± 73.4	268.1 ± 84.8	294.3 ± 58.3	3.04.1 ± 45.3	**0.02**
Others					
Glucose(mmol/l)	5.47 ± 0.7	5.9 ± 0.6	5.9 ± 1.5	5.92 ± 1.1	0.18

ABBREVIATIONS: ALT- Alanine transaminase, AST- Aspartate transaminase, GGT- Gamma Glutamyl transaminase, T.Bil- Total Bilirubin, D.Bil- Direct Bilirubin, Ind.Bil-Indirect Bilirubin,T.Chol.-Total Cholesterol,HDL- High density lipoprotein, LDL-Low density lipoprotein and SD-Standard Deviation. Significant P-values (P<00.5) are in bold.

Table 4: It is a presentation of the results of the effect of smoke residues on the haematological parameters of all the participants who were sampled in the study. HGB, HCT, MCHC and PLT were significantly (P<0.05) higher in the test group when compared to the control.

Table 4: Effect of smoke residues on the haematological parameters of all participants.

Parameter	Test (n=75) Mean ± SD	Control (n=20) Mean ± SD	P-value
Haemoglobin (g/dL)	13.13 ± 1.45	12.24 ± 1.02	**0.030**
Haematocrit count (%)	39.15 ± 4.05	36.29 ± 2.98	**0.012**
RBC (x10^{12}/L)	4.71 ± 0.45	4.46 ± 0.47	0.056
MCV (fL)	83.49 ± 4.40	81.90 ± 7.88	0.361
MCH (pg)	30.01 ± 2.10	27.70 ± 3.67	0.690
MCHC (g/dL)	35.34 ± 1.10	27.70 ± 3.67	**0.000**
RDW SD (fL)	43.82 ± 3.80	42.38 ± 8.44	0.438
RDW CV (%)	14.85 ± 2.28	14.29 ± 1.26	0.081

WBC (x10^9/L)	5.74 ± 1.34	5.22 ± 0.96	0.540
Neutrophils (%)	48.38 ± 7.79	40.58 ± 6.61	0.071
Lymphocytes (%)	50.53 ± 5.81	46.73 ± 7.69	0.051
Mixed cells (%)	9.62 ± 3.37	9.38 ± 3.00	0.810
Neutrophils (x10^9/L)	2.64 ± 0.70	2.28 ± 0.49	0.844
Lymphocytes (x10^9/L)	1.21 ± 1.48	2.42 ± 0.70	0.072
Mixed cells (x10^9/L)	0.52 ± 0.19	0.56 ± 0.41	0.730
Platelets (x10^9/L)	215.04 ± 61.41	160.04 ± 59.85	**0.002**
PDW (fL)	13.33 ± 2.60	14.28 ± 2.35	0.182
MPV (fL)	10.16 ± 0.97	10.47 ± 2.11	0.836
P-LCR (%)	30.31 ± 7.13	31.70 ± 6.37	0.234

ABBREVIATIONS: RBC-Red Blood Cells, MCV- Mean Cell Volume, MCH-Mean Corpuscular Haemoglobin, MCHC-Mean Corpuscular Haemoglobin Concentration, RDW-Red cell Distribution Width reported statistically as standard deviation (SD) and coefficient of variation (CV), WBC-White Blood Cells, PDW-Platelet, MPV-Mean platelet Volume Distribution Width, P-LCR- Platelet Larger Cell ratio. Results are presented in mean ± standard deviations for both test and control, all taken at P<0.05 level of significance. Significant P-values (P<00.5) are in bold.

Table 5: Shows a significant (P<0.05) increase in the mean Haemoglobin, WBC and absolute Lymphocyte counts in participants exposed to the smoke between the duration of 1 – 5 years compared to higher years. There is significant increase in Neutrophils, differential Lymphocytes, and Platelets in participants exposed to smoke from 16 years and above.

Table 5: Haematological parameters of all the participants according to various duration of exposure

Parameter (years)	**1-5 (n=29)** Mean ± SD	**6 – 10(n=20)** Mean ± SD	**11 – 15(n=18)** Mean ± SD	**>16(n=8)** Mean ± SD	**P-value**
Heamoglobin (g/dL)	12.03 ± 1.06	12.8 ± 0.89	13.12 ± 0.84	13.4 ± 0.49	**0.049**
Heamatocrit count (%)	35.9 ± 2.47	36.8 ± 2.26	38.5 ± 3.56	39.3 ± 3.00	0.167
RBC (x10^{12}/L)	4.47 ± 0.32	4.53 ± 0.39	4.57 ± 0.63	4.21 ± 0.59	0.543
MCV (fL)	80.1 ± 6.29	80.9 ± 4.76	82.8 ± 7.74	83.4 ± 10.5	0.691
MCH (pg)	27.0 ± 2.51	26.8 ± 2.65	27.6 ± 2.90	28.6 ± 5.41	0.289
MCHC (g/dL)	32.8 ± 1.31	31.8 ± 1.11	32.7 ± 1.59	33.4 ± 1.81	0.691
RDW SD (fL)	42.1 ± 3.42	43.6 ± 2.27	44.8 ± 3.02	45.6 ± 5.10	0.052
RDW CV (%)	14.7 ± 1.30	14.4 ± 0.94	16.0 ± 3.31	16.1 ± 3.53	0.061
WBC (x10^9/L)	5.02 ± 1.08	5.31 ± 0.95	6.31 ± 0.63	6.71 ± 1.31	**0.041**
Neutrophils (%)	45.9 ± 7.58	46.2 ± 7.77	44.7 ± 5.05	47.9 ± 4.97	**0.032**
Lymphocytes (%)	49.8 ± 5.20	50.9 ± 7.35	52.3 ± 6.94	53.5 ± 5.54	**0.021**
Mixed cells (%)	9.45 ± 2.60	8.37 ± 1.61	8.39 ± 3.57	8.25 ± 3.93	0.069
Neutrophils (x10^9/L)	2.24 ± 0.59	2.27 ± 0.63	2.45 ± 0.78	2.90 ± 0.37	0.089
Lymphocytes (x10^9/L)	0.91 ± 1.39	1.61 ± 0.54	1.11 ± 0.80	1.62 ± 0.49	**0.012**
Mixed cells (x10^9/L)	0.54 ± 0.18	0.47 ± 0.14	0.42 ± 0.20	0.59 ± 0.13	0.210
Platelets (x10^9/L)	226.4 ± 64.8	200.3 ± 44.3	234.5 ± 61.7	238.4 ± 69.0	**0.039**
PDW (fL)	13.5 ± 3.30	13.8 ± 3.12	14.0 ± 1.91	14.2 ± 1.49	0.159
MPV (fL)	10.1 ± 1.06	10.6 ± 0.88	10.9 ± 0.49	10.7 ± 0.58	0.571
P-LCR (%)	29.7 ± 7.65	29.8 ± 6.67	26.2 ± 4.49	26.1 ± 4.53	0.336

ABBREVIATIONS: RBC-Red Blood Cells, MCV- Mean Cell Volume, MCH-Mean Corpuscular Haemoglobin, MCHC-Mean Corpuscular Haemoglobin Concentration, RDW-Red cell Distribution Width reported statistically as standard deviation (SD) and coefficient of variation (CV), WBC-White Blood Cells, PDW-Platelet, MPV-Mean platelet Volume Distribution Width, P-LCR- Platelet Larger Cell ratio. Results are presented in mean ± standard deviations, Analysis of variance (ANOVA) was to determine the variation of the exposure to smoke and taken at P<0.05 level of significance. Significant P-values (P<00.5) are in bold.

III. Discussion

This study was carried out to assess the effect of smoke residues on biochemical and haematological parameters of women using charcoal smoke for grilling fish at Mammy market of Mogadishu cantonment, Abuja. Table 1 showed that the mean age of the participants was 32.3 ± 6.3 and 32.0 ± 9.6 for test and control groups respectively with 23 (30.6%) having the duration of exposure of 16 years and above. In this study, 33 (44.0 %) and 37 (49.3 %) of the participants exposed to charcoal smoke had educational status of ordinary level and primary school respectively. Those that have no western education are 5 (6.6 %), this outcome confirms that most African individuals using wood as domestic source of fuel are rural dwellers with little education by the United Nations Millennium Programme (Rehfuess *et al.*, 2006). Similar findings have been reported across the globe in Shanghai (Kan *et al*., 2008), United States and Europe (Zeka *et al.*, 2006). Some substances in charcoal smoke such as polycyclic aromatic hydrocarbons (PAHs) which could be formed from combustion are identified to be carcinogens in humans. Their carcinogenicity is associated with their resultant covalent binding to targets that are critical in DNA (Boström *et al*., 2002). Such toxic compounds can affect all body organs and tissues and could be hereditary among generations (Lewtas, 1988).

In this study, Aspartate transaminase, (AST) is raised in acute liver damage, but is also present in red cells, cardiac and skeletal muscle and is therefore not specific to the liver. The ratio of AST to ALT is sometimes useful in differentiating between causes of liver damage. AST levels are raised in shock and after exercise (Hartzell et al., 1985). In table 2 and 3 it has shown that there is a non-statistically high serum AST in the test group as compared to the control group. This also applies to the group of test participants who are exposed to the smoke for more than 16 years. Serum AST is enzymes that act as sensitive indicators of hepatocellular damage. Even though the elevated values are not statistically significant, the study agrees with the findings Al Malki (Al-Malki, 2009) that showed no significant variation in AST levels in response to fire smoke exposure.

The study showed in Table 2 that Albumin is significantly higher ($P<0.05$) in the test participants (46.9 ± 3.2) that are associated with exposure to charcoal smoke compared to the unexposed control (37.6 ± 3.2) group. Albumin is the most abundant protein in the blood plasma (Czub *et al*., 2019). Albumin has specific binding sites for copper ions, which are able to accelerate free radical reactions, and albumin may function as an antioxidant by scavenging peroxyl radicals. This research finding showed that exposure to charcoal smoke is associated with significant alterations in HDL, LDL and triglycerides especially as the duration of exposure increases (Table 3). They are at high risk of developing coronary heart diseases. Particulate matter released from wood smoke can modify LDL cholesterol by accelerating its oxidation. Increased oxidized LDL cholesterol is thus a risk factor for cardiovascular diseases(Kim *et al*., 2014). Also, particulate matter has been revealed to alter the structure and function of HDL cholesterol through oxidative stress and inflammation, producing a reduced dysfunctional HDL cholesterol with a decreased anti-inflammatory ability(Araujo and Nel, 2009) and hence culminating in coronary heart diseases. The change in lipid profile over time can thus be attributed to the fact that, those with longer years of exposure to wood smoke are likely to be exposed to more particulate matter, as has been reported by other studies (Jousilahti *et al*., 1999).

Another enzyme, gamma glutamyl transferase (GGT) is an indicator of early liver cell damage or cholestatic disease. Serum level of Gamma GT is commonly elevated in patients with acute hepatitis although the rise in GGT is usually less than that of the transaminases. This research work showed a significant increase ($P<0.05$) in GGT as the duration of exposure increases (Table 3). GGT is increasingly recognized as a biomarker for the risk of developing cardiovascular and metabolic syndromes. (J. Wang *et al*., 2017)(Franzini *et al.,* 2017).Consequently, expanding our understanding of the relationships between the main exposures in our study and GGT levels has become increasingly important. In the present study, we demonstrate a gradual increase in GGT levels with increasing ($P<0.05$) in levels of exposure to smoke in Table 3. Since smoke is a risk factor are relatively prevalent in the general population, preventive health measures should be strengthened at all possible levels, and individuals should be encouraged to avoid the use of these intoxicants in combination, thereby reducing mortality and the possibility of developing various chronic diseases.

Health- damaging pollutants such as nitrogen dioxide and sulphur dioxide released from wood smoke render haemoglobin useless for oxygen transport by causing its conversion to methaemoglobin or sulfhaemoglobin (Badman and Jaffe, 1996).

Analysis of haematological parameters in Table 4, showed a higher hematological value in the exposed group than controls for Hb level, HCT count, MCHC, WBC count, lymphocytes, neutrophils, platelets and RDW parameters as the age increases .A comparisons were made to determine the impact of the duration of exposure on variation in heamatological parameters (Purbayanti *et al*., 2020). It was observed that where only heamoglobin, WBC, Neutrophils, Lymphocytes and Platelets parameters had a significant increase as the duration of exposure increases as shown in Table 5. Results show positive significance in Neutrophils, Lymphocytes, Platelets and WBC. These results are in line with previous studies which stated that there was an increase in Hb, WBC and platelet levels in healthy adults exposed to air pollution (Purbayanti *et al*., 2020) and (Honda *et al.,* 2017). Other research shows that air pollution exposure can increase Hb, HCT and MCHC levels (Abou-ElWafa *et al*., 2015). Another study reported the effects of CO exposure on hematological profiles, where Hb, HCT, WBC and platelets levels were elevated in patients with CO poisoning(Lee *et al*., 1994). Inhalation of CO exposure can quickly enter the circulatory system and bind to Hb 200 times stronger than oxygen to form carboxyhemoglobin, thus disrupting the oxygen transportation system to tissues, which can cause hypoxia (Metere *et al*., 2014). The condition of hypoxic tissue is a stimulus for erythropoiesis and stimulates the production of erythropoietin to produce more RBC and Hb in blood circulation(Pittman, 2011).

WBC counts can be used as a biomarker for endothelial damage. We found that fish traders who were exposed to grilled fish smoke had a higher WBC and neutrophil count than those who were not exposed (Table 4.). Carbon monoxide intoxication itself is associated with toxicity to WBC in the form of leukocytosis and neutrophilia (Steenhof *et al*., 2014)(Madjid and Fatemi, 2013). The systemic inflammatory response is characterized by the release of WBC and platelets in the circulation. Several studies have shown that the WBC level is a good predictor of atherosclerosis and cardiovascular disease(Madjid and Fatemi, 2013). A high WBC amount in exposed subjects can show that they may be at higher risk of developing atherosclerosis and cardiovascular disease than traders who are not exposed to smoke (Swirski and Nahrendorf, 2013).Increased platelet counts in healthy adult individuals who are exposed to long-term air pollutants, especially PM, shows a detrimental effect on blood clots(Zhang *et al*., 2018). Other studies have shown a significant increase in platelet counts in CO poisoning patients. Excess carbon monoxide in the body can activate platelets to produce NO which can react with superoxide to produce peroxynitrite and other ROS(Rose *et al.*, 2017). ROS can affect platelet aggregation and blood flow, contributing to endothelial damage. Besides, free radicals can increase platelet adhesion and cause changes in the fibrinolytic pathway (Rafieian-Kopaei *et al*., 2014).In addition, it is also known that there is a non significant increase in Platelet index (MPV and PDW) in grilled fish traders as the duration of exposure increases(Table 5), which is a biomarker of inflammation due to increased platelet activation (Purbayanti *et al*., 2020). The results of this study show that the content of hazardous compounds in grilled fish processing using charcoal can increase hematological values in the blood of exposed individuals, especially for parameters that lead to an inflammatory response. However, this study had some limitations. First, all test subjects were female except for the control groups and because there are several factors such as ranges of Hb and MCHC which are influenced by the gender of the test subjects, the results of this study could only describe conditions in female test subjects. Secondly, the advent of Covid-19 pandemic in 2020 and subsequent lock down in economic activities hindered more subjects to participate in the research.

IV. Conclusion

This research has succeeded in showing the effect of air pollution originating from smoked fish processing by grilling. Exposure to charcoal smoke is associated with significant alterations in, HDL, Triglycerides, LDL especially as the duration of exposure increases (Table 3). They are at high risk of developing coronary heart diseases. GGT is an indicator of early liver cell damage or cholestatic disease. Serum level of Gamma GT is commonly elevated in patients with acute hepatitis although the rise in GGT is usually less than that of the transaminases. This research has succeeded in showing the impact of air pollution originating from smoked fish processing by grilling. Decrease in the value of lymphocytes and mixed cells accompanied by the increase of Hb, HCT, MCHC, WBC, platelets, lymphocytes and neutrophils values is caused by exposure to hazardous chemicals contained in grilled fish smoke which have the potential to lead to health problems and disease progression. Research similar to different observation objects must be carried out in order to ascertain the effects of exposure to air pollutants from other objects, especially with larger sample quantities.

V. Recommendation

Similar research work should be replicated in other parts of Abuja, Nigeria to establish a prevalence rate of the effect of smoke residues of women fish grillers. They should be given public health awareness on the implication of the possible effect of smoke. The management of the Mammy market should encourage them on the need for regular medical examination by a recommended medical facility. This will help in early detection of any biochemical and haematological changes that might occur in their body systems and early treatment where necessary.

Further research studies should be carried out in order to ascertain the effects of exposure to smoke from fish grilling. This will include estimation of Lipid peroxidation, Particulate matter (PM), Carbon monoxide (CO), Polycyclic aromatic hydrocarbons (PAHs), nitrogen oxides (NO), Sulfur dioxide, volatile organic compounds, heavy metals (Fluoride, Arsenic, Lead, Mercury and Selenium) and other toxic compounds.

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