

## Population-Based Full Blood Count Reference Intervals in Lagos, Nigeria

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## Abstract

**Background:** The Clinical and Laboratory Standard Institute, USA, recommends that reference intervals of laboratory parameters should be established for each locality. This study is aimed at determining full blood count reference parameters interval of adults in Lagos State, Nigeria. **Methods:** This was a population-based, cross-sectional study conducted at Lagos State University Teaching Hospital, Ikeja in August 2022 involving all the five divisions of Lagos State. Apparently healthy three hundred and eighty-four (384) participants with ages between 18-89 years were enrolled into the study and venous blood samples were collected from them for full blood count analysis using Sysmex KN-21 N machine. Data were analyzed with Statistical Package for Social Sciences, Inc., Chicago, Ill version 26.0. The mean, minimum, maximum and gender-specific data were obtained, p value was set at  $\leq 0.05$ . Ethical approval was obtained from the Institution before the commencement of the study. **Results:** After data cleaning, a total of Three Hundred and Thirty-Five (335) healthy participants' data were analyzed showing a mean age of  $49.74 \pm 75$  years. There were 185 (55%) females and 150 (45%) males. Most of the red blood cell parameters were statistically lower in females than males, while the white blood cell and platelet count parameters were higher in females than males. **Conclusion:** The red blood cells parameters were lower in females than males while the platelet count, total white blood cells and neutrophils/lymphocytes differentials were lower in males than females.

**Keywords:** Reference Interval, Full Blood Count, Population Study.

## INTRODUCTION

The range of outcomes expected in a healthy population for a clinical or a diagnostic measurement is referred to as the population reference interval (RI).<sup>1</sup> Geographical, racial, socio-economic, age, and gender impact RI.<sup>2</sup> The use of an inappropriate RI for a particular factor, e.g., age, sex, race, etc. accounts for patients' mismanagement.<sup>3</sup> Despite many published full blood count reference intervals of African Populations, there are significant inter-regional, inter-laboratory and method-dependent variations in full blood count parameters which may be due to reference population characteristics.<sup>4</sup> Secondly, in low and medium-resource countries, such as Nigeria, clinicians rely on obsolete, manufacturers' and Caucasian RIs because of poor productive capacity.<sup>5</sup> This may be misleading, resulting in misdiagnosis and inappropriate

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management, hence, the need to conduct this study to determine a population-based RI of adult full blood count in Lagos State, Southwestern Nigeria.

Determination of reference intervals requires a minimum sample size of one hundred and twenty healthy participants for such parameters in a population, <sup>6</sup> this study bled a total of three hundred and eighty-four participants spread over the five divisions of Lagos State. The sample size is much higher than the recommended guideline. The study is aimed at determining adult population reference intervals of full blood count in all the five divisions of Lagos State, Nigeria.

## METHODS

### Study location

The study was conducted in Lagos State located in southwestern Nigeria.

### Study population

The study participants were recruited in August 2022 from communities within the five divisions of Lagos State i.e., Ikeja, Ikorodu, Lagos Island, Epe, and Badagry (Table 1)

### Study design

This study was a population-based, descriptive, and cross-sectional study.

### Sample size calculation

The sample size was determined using the statistical formula that applies to surveys. <sup>7</sup> Numeric outcome (mean).

$$N = Z_{\alpha}^2 \sigma^2 / \delta^2$$

N=Sample size  
 $Z_{\alpha}$ = Normal Standard Deviate for  $\alpha$ -error =1.960  
 $\sigma$ =variance =50% (0.5)  
 $\delta$  =Precision level assumed at 5% (0.05)  
 $N = \frac{(1.96)^2 * (0.5)^2}{(0.05)^2}$   
 $= 3.84 * 0.25 / 0.0025 = 0.96 / 0.0025 = 384$

### Sampling technique

A multistage sampling technique was used. In the first stage, all five divisions were included in the study. Subsequently, communities were divided into clusters as the sampling units in the five divisions from which communities were randomly selected in each of the divisions. Participants were recruited consecutively as they consented to participate in the study.

### Inclusion criteria

Apparently healthy consenting adults willing to participate in the study.

### Exclusion criteria

Adults with severe known co-morbidities such as diabetes mellitus, obesity and hypertension, recent blood transfusion, sickle cell disease

### Data Collection Tools

With the use of an interviewer-administered questionnaire, each participant was interviewed to

obtain relevant socio-demographic, and anthropometric data including weight, height, body mass index, and waist circumference which were documented. Clinical data such as age, history of blood transfusion, and drug history obtained. Random blood glucose (RBS), blood pressure measurement, and a brief clinical examination were conducted.

### Bias

Data on those with risk factors such as obesity, diabetic Mellitus (DM), smoking and chronic alcoholism were deleted from the database before the final analysis.

### Sample Collection

Four and a half millilitres of venous blood were collected from each study participant under aseptic techniques. This was dispensed into a potassium ethylene diamine tetra-acetate (K3EDTA) specimen bottle. The samples were transported in ice packs from the field to the laboratory. The samples were used for full blood count (FBC) and analysed within 6 hours of collection.

### Laboratory Analysis

The samples were transported to and run at the Medical Research Council (MRC) Laboratory of Lagos State University, College of Medicine using Sysmex KN-21 N (Sysmex corporation Kobe, Japan). It is a three-part auto-analyser that runs 19 parameters per sample including red blood cell concentration, haemoglobin concentration, haematocrit, mean corpuscular haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin concentration, red cell distribution width, white blood cells and differentials, platelet count, mean platelet volume, platelet distribution width and platelet crit.

### Statistical analysis

Data were analysed using SPSS version 26.0 (Statistical Package for Social Sciences, Inc., Chicago, Ill). There were no missing data. The data were tested for normality by performing skewness and Kolmogorov-Sminorv/Shapiro-Wilk tests. The lower and upper reference limits for the continuous variables were expressed as 2.5 percentiles and 97.5 percentiles respectively. P-value was statistically significant when at  $P \leq 0.05$ .

### Ethical Considerations

Ethical committee approval was obtained before the commencement of the study from the Health Ethics and Research Committee of Lagos State University Teaching Hospital. The approval was obtained on 1<sup>st</sup> August 2022 with a reference number LREC/06/10/1886. The participants were informed about the study, as well as their rights and benefits. Written informed consent was obtained from each participant using voluntarily signed consent forms. No participant was coerced in any way to participate in this study, which was at no cost to them.

**RESULTS**

A total of Three Hundred and Eighty-Four (384) were recruited, however, following data cleaning, 49 participants with elevated RBS greater than 200mg%, those with abnormal FBC parameters of unknown causes, those with previous history of blood transfusion, and those with smoking history were excluded from the analysis, only Three Hundred and Thirty-Five (335) healthy participants were left.

Table 1: The five divisions and the study participants' communities

SN	Division	Community	Number
1	Ikeja	Akowonjo	38
2	Ikorodu	Ita Elewa	44
3	Lagos Island	Ijora Oloye & Mushin Wards	171
4	Epe	Local Government Community	43
5	Badagry	Ajara Community	39
<b>Total</b>			<b>335</b>

Key: SN; Serial Number

Table 2: The 2.5 and 97.5 Percentiles of White Blood Cell Count, Red Blood Cell Count, Haemoglobin concentration, Haematocrit, Red Blood Cell Indices, and Platelets Count

N	WBC × 10 <sup>9</sup> /L		RBC × 10 <sup>12</sup> /L		Hgb g/dl		HCT %		
	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	
	Total	335	3.64	9.27	3.82	5.90	10.20	15.80	32.13
Male	152	3.65	8.81	3.97	6.18	10.45	15.94	32.58	48.41
Female	183	3.60	9.74	3.72	5.65	9.90	14.72	30.90	43.68
18-30 years	51	3.68	11.15	3.12	5.89	9.95	15.68	28.87	46.72
31-40 years	50	3.58	9.84	3.39	6.22	9.68	15.30	30.24	46.88
41-50 years	83	3.70	9.28	3.87	5.90	9.16	16.07	31.64	48.99
51-60 years	76	3.56	7.56	4.00	5.64	10.47	16.03	33.40	48.43
61-70 years	60	3.50	15.19	3.72	6.49	9.46	16.13	29.80	47.83
71-80 years	9	4.20	No figure generated	4.41	No figure generated	12.00	No figure generated	37.90	No figure generated
81-90 years	6	4.60	No figure generated	4.16	No figure generated	10.50	No figure generated	32.10	No figure generated

N	MCV fl		MCH pg		MCHC g/dl		Platelet Count × 10 <sup>9</sup> /L		
	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	
	Total	335	68.87	92.50	21.13	30.86	30.13	34.96	127.05
Male	152	68.77	90.43	22.34	30.44	30.45	34.94	120.83	384.57
Female	183	67.06	93.48	20.66	31.36	29.90	35.00	127.00	418.40
18-30 years	51	71.05	93.62	21.83	32.20	30.45	34.83	103.00	439.13
31-40 years	50	61.76	91.70	19.12	31.00	29.98	35.29	156.30	418.70
41-50 years	83	70.61	93.58	21.96	31.56	30.50	34.90	70.90	406.80
51-60 years	76	66.66	90.64	21.37	32.25	29.88	35.51	133.63	446.10
61-70 years	60	68.01	93.28	21.42	31.06	30.08	35.36	80.30	389.55
71-80 years	9	73.10	No figure generated	22.60	No figure generated	29.80	No figure generated	134.00	No figure generated
81-90 years	6	65.80	No figure generated	20.70	No figure generated	31.20	No figure generated	164.00	No figure generated

Keys: WBC: White Blood Cell; RBC: Red Blood Cell; HGB; Haemoglobin; HCT; Haematocrit; MCV-Mean Cell Volume, MCH-Mean Haemoglobin Concentration, MCHC-Mean Corpuscular Haemoglobin Concentration.

Table 3: The Mean Values of Red Blood Cell Count, Haemoglobin concentration, haematocrit and Red Blood Cell Indices, White Blood Cell Count and Platelets Count

	WBC × 10 <sup>9</sup> /L Mean ± SD	RBC × 10 <sup>12</sup> /L Mean ± SD	Hgb g/dl Mean ± SD	HCT % Mean ± SD
Overall	5.8±1.43	4.76±0.5	12.71±1.39	38.81±3.86
Male	5.6±1.34	5.01±0.5	13.47±1.33	40.99±3.72
Female	5.90±1.49	4.56±0.47	12.09±1.09	37.04±2.98
18-30 years	5.90±1.24	4.69±0.59	12.64±1.44	38.63±4.28
31-40 years	5.94±1.53	4.77±0.59	12.64±1.44	38.39±4.68
41-50 years	5.96±1.44	4.77±0.56	12.81±1.56	39.05±4.20
51-60 years	5.35±1.15	4.76±0.45	12.78±1.30	39.03±3.69
61-70 years	5.96±2.15	4.77±0.62	12.84±1.33	39.05±3.96
71-80 years	5.92±1.50	4.85±0.42	12.37±0.87	38.60±2.36
81-90 years	6.06±1.51	4.59±0.57	11.61±1.47	36.20±3.84

	MCV fl Mean ± SD	MCH pg Mean ± SD	MCHC g/dl Mean ± SD	Platelet Count × 10 <sup>9</sup> /L Mean ± SD
Overall	69.96±0.42	56.26±17.71	32.76±1.02	253.92±71.35
Male	68.73±44.65	25.99±7.50	32.88±1.10	235.03±65.24
Female	70.97±40.85	27.43±22.95	32.65±1.28	269.57±72.57
18-30 years	82.59±4.06	27.03±1.64	32.71±1.00	278.65±77.43
31-40 years	61.18±53.95	25.63±7.85	32.87±1.34	258.34±60.56
41-50 years	80.14±19.00	26.95±2.44	32.77±1.22	242.34±76.05
51-60 years	68.78±44.22	28.71±35.32	32.83±1.27	256.30±77.10
61-70 years	62.24±54.50	27.03±2.17	32.87±1.06	242.42±73.60
71-80 years	42.26±70.17	19.09±16.83	32.04±1.27	242.65±68.73
81-90 years	79.28±70.17	25.43±2.65	32.04±1.27	239.65±49.22

The minimum and maximum ages of participants were 18 and 89 years respectively and a mean age of 49.74±75 years. The gender distribution consisted of 185 (55%) females and 150 (45%) males. The 2.5 and 97.5 percentile values for Red Blood Cell Count.

Table 4: The 2.5 and 97.5 Percentiles of WBC differentials, RDWSD, RDWCV, PDW, MPV, PLCR, and PCT

N	Lym%		MXD%		Neut %		Lym #	MXD#	Neut #				
	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile							
	Total	33	23.75	60.66	2.43	23.39				25.01	68.58	1.33	4.10
Male	15	22.13	60.49	1.80	24.34	8.23	69.74	1.30	4.02	1.80	2.34	1.27	5.01
Female	18	24.00	62.46	2.62	24.38	25.16	64.74	1.40	4.24	1.00	1.68	1.18	5.58
18-30 Yrs	51	21.05	61.77	2.76	20.56	21.85	70.45	1.30	4.65	0.20	1.37	1.31	5.57
31-40 Yrs	50	19.82	72.20	1.96	15.10	21.99	73.73	1.08	4.14	0.10	1.14	0.93	6.88
41-50 Yrs	83	28.61	57.93	1.83	28.90	24.24	65.29	1.41	3.99	0.10	1.47	1.13	5.17
51-60 Yrs	76	30.28	60.97	2.44	28.49	20.33	64.04	1.48	4.11	0.10	1.82	0.98	4.10
61-70 Yrs	60	11.55	60.69	1.85	46.47	28.68	77.36	1.29	4.19	0.04	4.22	1.33	9.46
71-80 Yrs	9	33.10	No figure	5.20	No figure	42.4	No figure	2.30	0.30	No figure	1.40	No figure	No figure
81-90 Yrs	6	29.20	No figure	5.70	No figure	40.70	No figure	1.60	0.30	No figure	2.2	No figure	No figure

N	RDWSD		RDWCV		PDW		MPV		PLCR		PCT		
	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	2.5 Percentile	97.5 Percentile	
	Total	33	37.33	50.89	12.20	17.40	10.20	17.43	9.00	12.30	16.66	43.68	0.14
Male	15	37.26	51.10	12.15	17.44	10.15	17.69	8.97	12.32	16.39	43.41	0.13	0.41
Female	18	37.22	51.14	12.12	17.76	10.14	17.35	9.00	12.35	16.82	43.90	0.13	0.43
18-30 Yrs	51	38.15	64.32	11.82	19.43	9.91	22.93	8.55	12.66	14.42	45.33	0.12	0.50
31-40 Yrs	50	33.03	48.18	11.78	18.48	10.22	17.15	9.19	13.01	17.94	49.25	0.15	0.41
41-50 Yrs	83	36.31	53.48	11.93	18.30	9.63	18.28	8.90	12.19	14.97	43.77	0.07	0.41
51-60 Yrs	76	37.98	48.22	12.34	16.13	9.86	16.35	8.97	12.43	16.72	44.16	0.14	0.42
61-70 Yrs	60	36.59	50.94	12.20	17.89	10.24	19.64	8.94	12.30	16.37	42.91	0.09	0.41
71-80 Yrs	9	41.00	No figure generated	13.00	No figure generated	10.80	No figure generated	9.70	No figure	21.20	No figure	0.15	No figure
81-90 Yrs	6	36.70	No figure	13.30	No figure	11.00	No figure	9.60	No figure	21.60	No figure	0.18	No figure

Keys: Lym%-Lymphocyte Percentage, MXD%-Mixed Percentage, - - Neut %-Neutrophil Percentage,----Lym#-Lymphocyte Number,--MXD#-Mixed Number, Neut#-Neutrophil Number, RDWSD Red Cell Distribution Width Standard Deviation,-----RDWCV- Red Cell Distribution Width Coefficient of Variation, -----PDW-Platelet Distribution Width,-----MPV-Mean Platelet Volume, PLCR-Platelet Large Cell Ratio, PCT-Plateletcrit, Yrs-Years

Table 5: Mean Values of WBC differentials, RDWSD, RDWCV, PDW, MPV, PLCR, and PCT

	Lym% Mean ± SD	MXD% Mean ± SD	Neut% Mean ± SD	Lym# Mean ± SD	MXD# Mean ± SD	Neut# Mean ± SD
Overall	43.19±9.33	39.91±0.5	46.71±13.66	2.51±1.01	0.57±0.45	2.79±1.1
Male	42.85±9.96	10.20±5.8	45.62±16.29	2.39±0.68	0.57±0.31	2.72±1.12
Female	43.46±8.78	9.66±5.35	46.70±11.06	2.61±1.20	0.58±0.55	2.80±1.07
18-30 Yrs	44.33±9.95	10.35±4.21	45.02±10.61	2.65±0.79	0.61±0.28	2.68±0.79
31-40 Yrs	44.32±11.41	8.41±3.41	47.16±11.37	2.56±0.67	0.51±0.26	2.90±1.30
41-50 Yrs	43.16±7.81	9.78±5.92	46.69±13.18	2.52±0.66	0.55±0.31	2.87±0.96
51-60 Yrs	45.18±8.51	10.21±5.06	43.65±13.11	2.42±0.67	0.54±0.33	2.42±0.75
61-70 Yrs	40.18±10.34	10.71±7.90	49.93±10.92	2.28±0.69	0.66±0.85	3.01±1.49
71-80 Yrs	42.54±7.37	9.64±4.65	38.52±30.26	3.30±3.28	0.59±0.43	2.87±1.04
81-90 Yrs	37.30±6.65	12.48±5.49	50.12±7.15	2.20±0.49	0.81±0.53	3.00±0.83
	RDWSD Mean ± SD	RDWCV Mean ± SD	PDW Mean ± SD	MPV Mean ± SD	PLCR Mean ± SD	PCT Mean ± SD
Overall	43.19±3.69	14.23±6.37	13.01±1.95	10.56±0.86	30.79±18.52	0.26±0.07
Male	43.22±3.22	14.59±9.36	13.13±1.86	10.59±0.86	31.48±26.38	0.24±0.06
Female	43.17±4.0	13.93±1.36	12.91±2.02	10.53±0.82	28.88±6.64	0.28±0.07
18-30 Yrs	42.84±2.13	43.03±4.8	13.04±1.55	10.66±0.91	29.94±7.43	0.29±0.84
31-40 Yrs	42.12±3.04	13.72±1.35	12.81±1.72	10.53±0.81	28.70±6.4	0.27±0.56
41-50 Yrs	43.04±4.74	15.22±12.59	13.12±1.96	10.56±0.84	33.12±35.48	0.25±0.07
51-60 Yrs	43.16±2.56	13.75±1.07	12.76±1.64	10.50±0.81	28.73±6.56	0.26±0.72
61-70 Yrs	44.17±3.02	14.15±1.21	13.27±2.13	10.55±0.90	29.21±6.72	0.25±0.69
71-80 Yrs	44.14±2.76	14.67±1.53	13.54±1.47	10.83±0.67	31.54±5.36	0.26±0.70
81-90 Yrs	44.13±5.53	14.76±1.28	12.46±1.94	10.46±0.64	28.21±6.21	0.25±0.55

Haemoglobin concentration, haematocrit and Red Blood Cell Indices, White Blood Cell Count and Platelets Count are presented in Table 2 while the mean values of the same parameters are presented in Table 3.

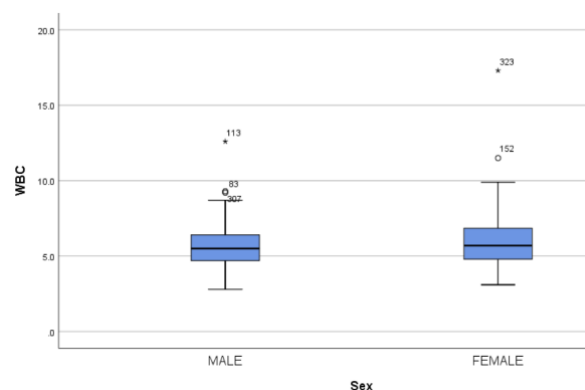
Table 6: Gender-Specific Full Blood Count parameters of all participants and the p-values.

	Male N=150	Female N=185	t-Score	p-value
RBCC × 10 <sup>9</sup> /L	5.01±0.5	4.56±0.47	8.41	0.01
Hgb g/dl	13.47±1.33	12.09±1.09	10.22	0.01
HCT %	40.94±3.72	37.04±2.98	10.41	0.01
WBC × 10 <sup>9</sup> /L	5.6±1.34	5.90±1.49	1.93	0.10
MCV fl	68.73±44.65	70.97±40.85	0.47	0.63
MCH pg	25.99±7.50	27.43±22.95	0.80	0.84
MCHC g/dl	32.88±1.10	32.65±1.28	1.76	0.15
Platelet Count×10 <sup>9</sup> /L	235.03±65.24	269.57±72.57	4.58	0.01
Lym%	42.85±9.96	43.46±8.78	0.58	0.55
Mxd%	10.22±5.8	9.66±5.35	0.90	0.72
Neut%	45.62±16.29	46.70±11.06	0.69	0.97
Lym#	2.39±0.68	2.61±1.20	2.11	0.06
Mxd#	0.57±0.31	0.58±0.55	0.20	0.83
Neut #	2.72±1.12	2.85±1.07	1.07	0.56
RDW SD	43.22±3.22	43.17±4.0	0.12	0.90
RDW CV	14.59±9.36	13.93±1.36	0.85	0.78
PDW	13.13±1.86	12.91±2.02	1.03	0.60
MPV	10.59±0.86	10.53±0.82	0.64	0.50
PLCR	31.48±26.38	28.88±6.64	1.17	0.47
PCT	0.24±0.06	0.28±0.07	5.62	0.01

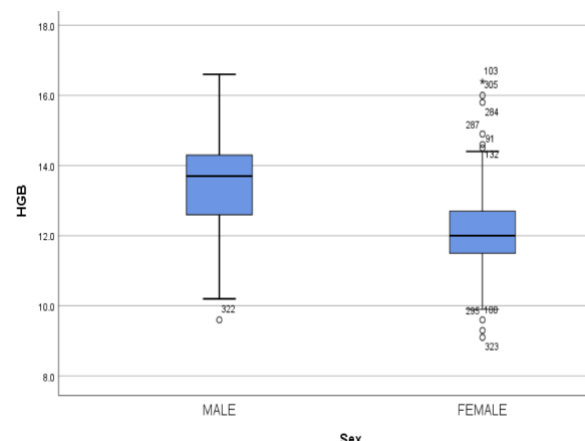
Keys: RBCC- Red Blood Cell Count, Hgb- Haemoglobin, HCT- Haematocrit, WBC-White Blood Cell Count, MCV-Mean Cell Volume, MCH- Mean Haemoglobin Concentration, MCHC-Mean Corpuscular Haemoglobin Concentration, Lym%-Lymphocyte Percentage, MXD%-Mixed Percentage,--Neut%-Neutrophil Percentage,----Lym#-Lymphocyte Number,-- MXD#-Mixed Number, Neut#-Neutrophil Number, RDWSD Red Cell Distribution Width Standard Deviation,-----RDWCV- Red Cell Distribution Width Coefficient of Variation, -----PDW-Platelet Distribution Width,----MPV-Mean Platelet Volume, PLCR-Platelet Large Cell Ratio, PCT-Plateletcrit

Table 4 presents the 2.5 and 97.5 percentile values for WBC differentials, red cell distribution width standard deviation (RDWSD), red cell distribution width coefficient variation (RDWCV), platelet distribution width (PDW), mean platelet volume (MPV), platelet large cell ratio (PLCR), and plateletcrit (PCT); the respective mean values are presented in Table 5. Table

6 presents the Gender-Specific Full Blood Count parameters of all participants and the p-values. Gender-specific box plots of WBC, Hgb, Platelet count, MCV and MCHC are presented in figures 1-5 respectively.

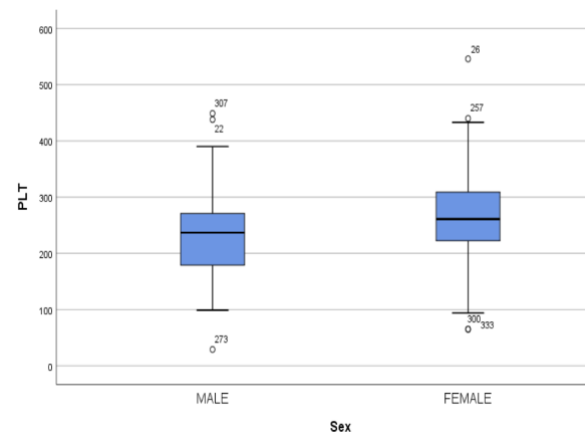


Key: WBC---White Blood Cell



Key: HGB-Haemoglobin

Figure 2: Gender- Specific Box Plots of HGB



Key: Platelet Count

Figure 3: Gender- Specific Box Plots of Platelet Count



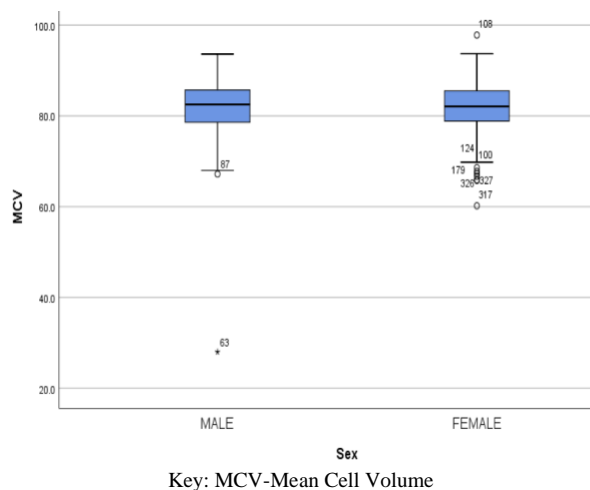
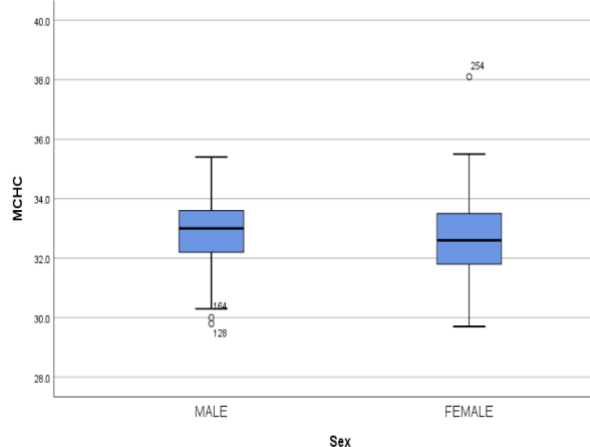


Figure 4: Gender- Specific Box Plots of Mean Cell Volume



Key: MCHC—Mean Corpuscular Haemoglobin Concentration

Figure 5: Gender- Specific Box Plots of Mean Corpuscular Haemoglobin Concentration

## DISCUSSION

The Clinical and Laboratory Standard Institute (CLSI) recommends that reference intervals of laboratory parameters should be established for each locality<sup>8</sup> either by *a priori* or *posteriori* sampling method.<sup>6</sup> *A priori* involves adoption of well-defined and exclusion criteria in the selection of samples, while *posteriori* is the establishment of reference intervals from a given population after the analyte has been tested. This study adopted the *posteriori* method to establish adults' FBC reference intervals living in Lagos State, Nigeria.

A quarter (25.1%) of this study's participants were between 51-60 years and almost another quarter (23%) were between 61-70 years. This is followed by 71-80 years (17%) and 41-50 years (14.9%). The implication of the age groupings is that the data obtained in this study were largely of the middle age to the elderly populations.

The red blood cell parameters data obtained in this study were because of the geographical location of Lagos which is 41m (135ft) elevated above sea level.<sup>9</sup>

Low oxygen tension at high altitude stimulates erythropoiesis and accounts for higher PCV and Hgb in mountainous regions.<sup>10</sup>

The mean red cell parameters obtained in this study for both males and females were lower than values obtained in Macedonia<sup>11</sup> because of racial differences though very similar but lower than values obtained in Bamenda, Cameroun because of geographical differences.<sup>12</sup> Gender, age, racial, ethnic, and geographic origin of the population impact on FBC Parameters.<sup>4,13</sup>

Unlike the mean cell volume (MCV) and mean cell haemoglobin (MCH), the mean cell haemoglobin concentration (MCHC), packed cell volume (PCV) and red blood cell concentration (RBC) concentrates values obtained in this study were significantly higher in males than females, this is in keeping with various studies in different part of Africa,<sup>14-17</sup> and in Nigeria.<sup>18</sup> Menstrual loss in females and the inhibitory effects of oestrogen on erythropoiesis in females could account for the lower HGB, PCV and red cell concentration in females.<sup>19</sup> However, the stimulatory effect of androgens on erythropoiesis in males often accounts for a higher haemoglobin (HGB), PCV, and red cell concentration in males.<sup>20</sup>

Like previous studies in Cameroun,<sup>12</sup> Ghana,<sup>15</sup> Ethiopia,<sup>17</sup> and Nigeria<sup>[18]</sup> unlike the PDW, MPV, and PLCR, the PCT and platelet count were statistically higher among females than males in Lagos which may be secondary to the lower level of HGB, and PCV in females resulting in higher level of erythropoietin. Due to structural similarity, erythropoietin has a costimulatory effect on erythropoiesis and megakaryopoiesis.<sup>18</sup>

This study reported total WBC and neutrophils/lymphocytes differentials were lower in males than females though not statistically significant. Hormonal changes in females and use some oral contraceptives have been reported to elevate WBC count in females.<sup>21</sup>

The overall total WBC count reference range obtained in Lagos was lower than the known Caucasian value of  $4-11 \times 10^9/L$  and the mean was also lower than  $7.5 \times 10^9/L$  obtained in Britain<sup>22</sup>. The lower count reported in Blacks may be genetic or environmentally induced.<sup>23</sup> It is estimated<sup>24</sup> 25-50% Africans have benign ethnic neutropenia which does not increase their susceptibility to infection or any other adverse reaction.

**Limitations:** One limitation of the study is the reliability on information provided by the participants regarding history of blood transfusion, and drug history, secondly, participants were not screened for infectious diseases such as HIV and hepatitis which could have impacted on the results obtained, however, abnormal results of unknown causes were excluded from the overall data during data cleaning.

## CONCLUSION

In conclusion, females had lower red blood cells parameters than males while the males had lower platelet counts and total WBC, neutrophils/lymphocytes differentials than females. The white blood cell count normal value in Lagos could be as low as  $2.8 \times 10^9/L$  and as high as  $12.6 \times 10^9/L$

### What is Known of this Topic.

- There are various published studies on population-based full blood count in Africa and the World in general.
- Secondly, it is well established that red blood cells parameters and white blood cell count are generally lower in Africans compared with Caucasians, while platelet count are generally higher in Blacks compared with Caucasians.

### What this Topic adds

- This study is providing the full blood count parameters in Lagos, to be best of our knowledge, this is the first study in Lagos depicting reference ranges of full blood count parameters among adults.
- Secondly, Physicians in Lagos and Nigeria use white blood cell count of  $4-11 \times 10^9/L$  as normal reference which is a textbook, and Caucasian value, this study has demonstrated that the white blood cell count normal value in Lagos could be as low as  $2.8 \times 10^9/L$  and as high as  $12.6 \times 10^9/L$

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