H. O. Olawumi, FWACP, I. A. Durotoye, FMCPath, Department of Haematology, J. K. Afolabi, FMCPaed, Department of Paediatrics and Child Health, A. Fadeyi, FMCPath, Department of Medical Microbiology and Parasitology, O. O. Desalu, FMCP, Department of Medicine, S. A. Aderibigbe, FWCP, Department of Community Medicine, A. S. Babatunde, FMCPath, Department of Haematology, S. K. Ernest, FWACP, Department of Paediatrics and Child Health, A. E. Fawibe, FMCP, Department of Medicine, A. K. Salami, FWACP, Department of Medicine, R. Saadu, FMCOG, Department of Obstetrics and Gynaecology, M. A. N. Adeboye, FMCPaed, Department of Paediatrics and Child Health and A. P. Aboyeji, FWACS, Department of Obstetrics and Gynaecology, University of Ilorin, Nigeria

Request for reprints to: Dr H.O Olawumi, Department of Haematology, University of Ilorin, Nigeria, Email: toyem66@yahoo.com

REFERENCE VALUES OF HAEMATOLOGICAL PARAMETERS OF HEALTHY ADULTS IN THE NORTH CENTRAL ZONE OF NIGERIA

H. O. OLAWUMI, I. A. DUROTOYE, J. K. AFOLABI, A. FADEYI, O. O. DESALU, S. A. ADERIBIGBE, A. S. BABATUNDE, S. K. ERNEST, A. E. FAWIBE, A. K. SALAMI, R. SAADU, M. A. N. ADEBOYE and A. P. ABOYEJI

ABSTRACT

Background: **Haematological parameters differ from one population to another due to several factors. To determine the clinical implication of the blood parameters of an individual in the state of health or disease, we need to have the knowledge of the normal reference range for that locality.**
Objectives: **To determine the reference values of haematological parameters of apparently healthy adults in Ilorin.**
Design: **A descriptive cross sectional study.**
Setting: **Ilorin, North Central zone of Nigeria**
Subjects: **Nine hundred and ten (443 males and 467 females) randomly selected normal, HIV negative individuals aged 18-65 years**
Results: **The red blood cell count, Haemoglobin concentration, PCV and MCHC were significantly higher among males than females while the platelet count, total WBC count and absolute neutrophil count were significantly higher in females than in males. There was however no significant gender difference in the values of MCV, MCH and absolute lymphocyte count. The normal reference values obtained in this study were notably different from those that are used currently in the hospital.**
Conclusion: **The normal reference value obtained in this study was notable different from those that are currently used in the hospital. These findings will have clinical implications regarding the adjustment of our current reference values and definitely add value to the management of patients in this part of the country.**

INTRODUCTION

A full blood count is one of the most frequently requested investigations for routine medical checkup and preliminary investigation in the diagnosis of many diseases in every field of Medicine. It is also a common investigation used to monitor the treatment of several diseases especially in patients on cytotoxic drugs (1). The parameters in a full blood count also known as haematological parameters are affected by many different factors such as age, gender, race, altitude, exercise, pregnancy and others (2). The normal haematological reference values therefore differ among people of different races, ages and gender (3, 4).

Normal reference values for haemoglobin concentration, packed cell volume, total white cell count and platelet count are higher among Caucasians than the black race (5, 6, 7). The Values of haemoglobin concentration, packed cell volume (PCV) and red blood cell count are high at birth, fall during childhood, and rises gradually at puberty

until the normal adult value is reached and falls again during old age especially in men. These values are also higher in men than in women after puberty (8, 9). Sex differences are also seen with leukocyte counts; women have higher values compared to men between the ages of 21 and 50 years (3).

In order to interpret and determine the clinical implication of the full blood count of any individual in the state of health or disease we need to have the knowledge of the normal reference range for that locality. Several studies have been carried out to determine the reference values of hematological parameters among blacks in many countries including Nigeria (10,11) but none has been carried out in Ilorin which is in the middle belt and a gate way between the Northern and Southern part of Nigeria. The study was therefore designed to determine this reference values of haematological parameters of apparently healthy adults in Ilorin which may serve as standards for the interpretation of laboratory results in this locality and its environs.

MATERIALS AND METHODS

Study population: This was a population based cross-sectional study carried out in Ilorin metropolis between January to December 2012. Ilorin is the capital city of Kwara state, situated in the North Central geopolitical zone of Nigeria. It is located on the Latitude 8.50 North and 4.550 East.

Sample selection: Apparently healthy, HIV non-reactive adults aged 18 years and above resident in Ilorin and its environs constituted the study population. The participants were selected by simple random sampling technique from schools, churches, mosques, markets and barracks in and around Ilorin.

Each consented participant was assessed clinically by an adult physician for eligibility to take part in the study. The participants also completed a screening questionnaire. They were assessed for signs of febrile illnesses, malnutrition and chronic medical condition. In addition, they were questioned to determine their medication history with associated illness. Participants who gave history of systemic and local symptoms that were suggestive of diabetes mellitus, tuberculosis, cancer and physical appearance that was typical of malnutrition were excluded. Those who received blood transfusion within the last 6 months, pregnant women, and those on steroid or other immunosuppressive therapy were also excluded. HIV sero-reactivity of the participants was also determined and only those who were non-reactive were recruited into the study.

Data collection and Specimen handling: Blood specimens were collected from the participants between 9.00 am and 12 noon each day and transported to the Haematology laboratory of University of Ilorin Teaching Hospital (UITH), Ilorin for immediate processing and analysis. Participants' socio-demographic data and other clinically relevant information were also obtained at the time of recruitment.

HIV sero-reactivity was determined according to the National algorithm. Parallel screening was quickly carried out using two rapid kits and discordant results resolved with the 3rd kit (tie breaker). Three kits (Start Pack, Determine and Uni-gold) were used according to manufacturer's instruction. Participants were categorised as HIV non-reactive when there was no positive reaction to at least 2 rapid kits. FBC was determined within 6 hours of blood specimen collection with Automatic blood count analyzer Sysmex KX21 according to the manufacturer's instruction. The analyser was calibrated by standardized commercially prepared calibrators and the manufacturer's control samples were used to monitor the analyser's performance.

Participants were all counseled before the HIV screening test was done and were as well counseled before the results were disclosed to them. Some of them who were sero-reactive were referred to the HIV/AIDS clinic for documentation and initiation of care.

Ethical approval: University of Ilorin Teaching Hospital Ethical Review Committee which is a member of the National Health Research Ethics Council approved the study protocol. Written Informed consent of the participants was equally obtained. Patients that did not consent to participate in the study were excluded. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data analysis: Data were analysed using the statistical package for social science (SPSS, version 20). Normality of the parameters was determined using one sample Kolmogorov Smirnov test. Mean ±1.96 SD was considered as the normal range for variables with normal distribution, which contains 95% of normal individuals. When distribution was not normal, reference ranges were considered as values between 2.5 and 97.5 percentiles. Independent sample t-test was used to determine gender difference in mean and one sample t- test used to determine difference between mean of variables in our study with other studies. A p-value of < 0.05 was considered to be statistically significant.

RESULTS

Nine hundred and ten apparently normal adult subjects aged 18-65 years were recruited to this study. The median age was 33years, 443(48.7%) were males

while 467(51.3%) were females. The mean, standard deviation, median as well as 2.5 and 97.5 percentile reference intervals of the parameters for all the 910 subjects included in this study is shown in Table 1.

Table 1
Haematological parameters of the study population

Parameter	Mean ±SD	Median	2.5th -97.5th percentile
RBC(x10^{12}/l)	4.807±0.6503	4.770	3.698-6.147
HB(g/dl)	12.852±1.4421	12.700	10.400-15.800
PCV (%)	40.14±4.233	40.00	33.00-49.00
MCV(fl)	83.939±6.1020	84.200	70.200-95.000
MCH (pg)	26.949±2.3869	27.100	21.400-31.000
MCHC(g/dl)	32.068±1.1926	32.100	29.600-34.300
Platelet(x10^9/l)	187.73±65.156	184.00	64.65-332.05
WBC(x10^9/l)	5.666±1.4777	5.500	3.400-9.145
Neutrophils(x10^9/l)	2.383±0.9548	2.200	1.000-4.752
lymphocytes(x10^9/l)	2.566±0.7503	2.500	1.300-4.133

The red blood cell count, Haemoglobin concentration, PCV and MCHC were significantly higher among male than female while the platelet count, total WBC count and absolute neutrophil count were significantly higher in females than in males. (P-value less than 0.001 in each case). There was however no significant sex difference in the values of MCV, MCH and absolute lymphocyte count with p values of 0.197, 0.574 and 0.055 respectively. (Table 2)

Using the one sample Kolmogorov Smirnov test, none of the parameters had a normal distribution.

(Table 3). Values between 2.5 and 97.5 percentiles were therefore considered as the normal reference interval for the study population.

The normal reference values obtained in this study were compared with those in current use in the hospital and were found to be notably different. (Table 4) We also compared the mean values of haematological parameters in this study with that done in another part of Nigeria, some other African countries, Pakistan and the western world (Table 5 and 6).

Table 2
Comparative Haematological values by gender

Parameter	Male			Female			
	Mean ±SD	Median	2.5th -97.5th percentile	Mean ±SD	Median	2.5th -97.5th percentile	P values
RBC(x10^{12}/l)	5.148±0.5534	5.110	4.155-6.360	4.485±.5657	4.450	3.604-5.570	0.000
HB(g/dl)	13.805±1.1005	13.900	11.600-16.100	11.938±1.0983	11.800	9.958-14.485	0.000
PCV(%)	42.98±3.221	43.00	36.00-49.90	37.46±3.205	37.00	32.00-45.00	0.000
MCV(fl)	83.672±6.2556	83.672	70.010-95.280	84.196±5.9465	84.400	70.758-94.770	0.197
MCH(pg)	26.995±2.4701	27.100	21.300-31.000	26.905±2.3062	27.100	21.658-30.928	0.574
MCHC(g/dl)	32.203±1.2065	32.300	29.600-34.390	31.938±1.1658	31.900	29.558-34.200	0.001

Platelet (x10⁹/l)	174.44±60.396	173.00	60.10-306.80	200.48±67.044	197.50	75.15-340.70	0.000
WBC (x10⁹/l)	5.533±1.4174	5.400	3.320-8.690	5.793±1.5234	5.600	3.400-9.590	0.008
Neutrophils (x10⁹/l)	2.203±0.8402	2.100	0.928-4.300	2.547±1.0225	2.400	1.100-4.977	0.000
lymphocytes (x10⁹/l)	2.517±.8402	2.400	1.310-4.090	2.613±.7632	2.500	1.300-4.240	0.055

Table 3

Test of normality of the haematological parameters

Parameter	Kolmogorov-Smirnova		
	Statistic	df	Sig.
RBC	.039	858	.004
HBconc	.056	858	.000
PCV	.079	858	.000
MCV	.044	858	.001
MCH	.048	858	.000
MCHC	.043	858	.001
platelet	.033	858	.032
WBC	.069	858	.000
absneut	.100	858	.000
abslymph	.076	858	.000

Table 4

Comparison of haematological reference values obtain from this study against those in current use in the hospital

	Males		Females	
Parameter	In current use	current study	In current use	Current study
RBC(x10¹²/l)	4.5-6.5	4.155-6.360	3.8-5.8	3.604-5.570
HB(g/dl)	13-18	11.600-16.100	11.5-16.5	9.958-14.485
PCV(%)	40-54	36.00-49.90	37-47	32.00-45.00
MCV(fl)	76-96	70.010-95.280	76-96	70.758-94.770
MCH(pg)	27-32	21.300-31.000	27-32	21.658-30.928
MCHC(g/dl)	32-36	29.600-34.390	32-36	29.558-34.200
Platelet(x10⁹/l)	100-300	60.10-306.80	100-300	75.15-340.70
WBC(x10⁹/l)	2.5-10	3.320-8.690	2.5-10	3.400-9.590
Neutrophils(x10⁹/l)	1.25-5.75	0.928-4.300	1.25-5.75	1.100-4.977
lymphocytes(x10⁹/l)	0.65-4.15	1.310-4.090	0.65-4.15	1.300-4.240

Table 5
Comparison of mean of adult male haematological reference values obtain from this study against others

Parameter	Present study	Jos[12]	Ghana[13]	Ethiopia[14]	Pakistan[15]	Western[16]
RBC (x10^{12}/l)	5.148	5.20	4.84	5.1	5.39	5.50
HB (g/dl)	13.805	14.20	13.64	16.1	13.04	15.5
PCV (%)	42.98	44.19	42.20	48.3	39	47
MCV(fl)	83.672	85.52	88	ND	76.3	86
MCH (pg)	26.995	27.66	29.1	ND	25.54	29.5
MCHC (g/dl)	32.203	32.18	33.1	ND	32.27	32.5
Platelet (x10^9/l)	174.44	216.40	316	207	255	150-400
WBC (x10^9/l)	5.533	4.40	5.5	6.0	8.25	7.50

Table 6
Comparison of mean of adult female haematological reference values obtain from this study against others

Parameter	Present study	Jos[12]	Ghana[13]	Ethiopia[14]	Pakistan[15]	Western[16]
RBC(x10^{12}/l)	4.485	4.6	4.32	4.5	4.79	4.82
HB(g/dl)	11.938	12.75	12.3	14.3	11.63	14.0
PCV(%)	37.46	39.73	36.9	42	35	42
MCV(fl)	84.196	85.81	86	ND	73.84	86
MCH(pg)	26.905	27.57	28.4	ND	24.42	29.5
MCHC(g/dl)	31.938	32.06	33.1	ND	37.72	32.5
Platelet(x10^9/l)	200.48	240.95	309	202	279	150-400
WBC(x10^9/l)	5.793	4.61	5.3	6.2	8.42	7.50

DISCUSSION

In this study we have determined the reference ranges of haematological parameters among healthy adult population in Ilorin and its environs and it will add value to the management of patients in this part of the country.

The reference ranges for all the haematological parameters except the red cell indices(MCV, MCH, MCHC) obtained in this study were lower than that of the western world (16). This is in keeping with findings in other parts of Nigeria (12) and other African countries like Ghana (13), Uganda (17), and Kenya (18). The lower values of haematological parameters in most African countries compared to the western world may be due to malaria endemicity, intestinal parasite infestation, dietary, environmental and genetic factors(19). On the contrary some African countries like Tanzania (20) and Ethiopia (14) have higher value of Haemoglobin concentration and PCV that are similar to western values. Altitude induced erythropoiesis and dietary factors may play a role in this variation (14). The platelet count obtained in this study is lower than that obtained in the Jos study and other countries like Ghana, Ethiopia and Pakistan.

The white cell count is however higher than the value gotten in the Jos study. Environmental factors and diet may account for these differences.

In this study the red blood cell count, haemoglobin concentration, PCV were significantly higher among male than females. This is in keeping with findings in other studies in Nigeria, Africa and in the United States (12, 13, 17, 18, 20). The lower value in females is due to the effect of male hormone, androgen on erythropoiesis in males and the monthly menstrual loss of blood in females.

The platelet count was significantly higher in females than in males, similar differences have been previously reported in Jos, Uganda and Pakistan (12, 15, 17). However there was no significant sex difference in platelet count in studies conducted in Ghana and Ethiopia (13, 14). The monthly menstrual loss of blood in females with consequent stimulation of the bone marrow may lead to reactive increase in platelet production and this may account for the higher platelet count among females in this study.

The total white blood cell count and absolute neutrophil count were significantly higher among females than males in this study but there was no significant difference in the absolute lymphocyte

count. The difference in total white cell count can therefore be accounted for by the higher value of absolute neutrophil count in females. This finding is in keeping with the study in Pakistan (15) but in the Jos study and studies in other parts of Africa there was no significant sex difference in white cell count (12, 13, 17).

The haematological reference values obtained in this study were lower than those in current use in the hospital. The one in current use was adopted many years ago from studies carried out in other parts of Nigeria and Africa.

In conclusion, we have determined the normal reference intervals of haematological parameters among healthy adult population in Ilorin and its environs and found it to be remarkably different from the reference values that are currently used in the hospital. This finding will help us to adjust our reference values and it will definitely add value to the management of patients in this part of the country.

REFERENCES

1. George GB, Parker K. Understanding the complete blood count with differential. *J Perianesth Nurs* 2003;**18**:96-114.
2. Solberg HE editor Establishment and use of reference. 4th ed. Philadelphia: Elsevier Saunders; 2006.
3. Castro OL, Haddy TB, Rana SR. Age- and sex-related blood cell values in healthy black Americans. *Public Health Rep* 1987;**102**: 232-237.
4. Nduka N, Aneke C, Maxwell-Owhochuku S. Comparison of some haematological indices of Africans and Caucasians resident in the same Nigerian environment. *Haematologia(Budap)* 1988;**21**:57-63.
5. Dallman PR, Barr GD, Allen CM, Shinefield HR. Hemoglobin concentration in white, black, and Oriental children: is there a need for separate criteria in screening for anemia? *Am J Clin Nutr* 1978;**31**:377-380.
6. Ezeilo GC. Non-genetic neutropenia in Africans. . *Lancet* 1972;**2**:1003-1004.
7. Bain BJ. Ethnic and sex differences in the total and differential white cell count and platelet count. *J Clin Pathol* 1996;**49**:664-666.
8. Williams WJ. The effect of aging on the blood count. *Compr Ther* 1980;**6**:7-9.
9. Yip R, Johnson C, Dallman PR. Age-related changes in laboratory values used in the diagnosis of anemia and iron deficiency. *Am J Clin Nutr* 1984;**39**: 427-436
10. Ezeilo GC. Normal haematological values in adult Zambians. *East Afr Med J* 1972;**49**:94-100.
11. Grantham-McGregor SM, Desai P, Milner PF. Haematological levels in Jamaican infants. *Arch Dis Child* 1974;**49**:525-530.
12. Miri-Dashe T, Osawe S, Tokdung M, Daniel N, Choji RP, Mamman I, Deme K, Damulak D, Abimiku A. Comprehensive Reference Ranges for Hematology and Clinical Chemistry Laboratory Parameters Derived from Normal Nigerian Adults. *Plos One* 2014;**9**:1-10.
13. Dosoo DK, Kayan K, Adu-Gyasi D, Kwara E, Ocran J, Osei-Kwakye K, Mahama E, Amenga-Etego E, Bilson P, Asante KP, Koram KA, Owusu-Agyei S. Haematological and Biochemical Reference Values for Healthy Adults in the Middle Belt of Ghana. *Plos One* 2012;**7**:1-9.
14. Tsegaye A, Messele T, Tilahun T, Hailu E, Sahlu T, Doorly R, Fontanet AL, Rinke De Wit TF. Immunohematological Reference Ranges for Adult Ethiopians. *Clinica and Diagnostic Laboratory Immunology* 1999;**6**:410-414.
15. Khalid U, Zeeshan AS, Arif AR. Reference range values of haematological Parameters in healthy Pakistani adults. *Pak J Physiol* 2007;**3**:19-22.
16. Dacie JV, Lewis SM. Practical haematology 7th ed. London. Churchill Livingstone 1991.
17. Lugada ES, Mermin J, Kaharuza F, Ulvestad E, Were W, Langeland N, Asjo B, Malamba S, Downing R. Population-Based Hematologic and Immunologic Reference Values for a Healthy Ugandan Population. *Clinical and Diagnostic Laboratory Immunology* 2004;**11**:29-34.
18. Kibaya RS, Bautista CT, Sawe FK, Shaffer DN, Sateren WB, Scott PT, Michael NL, Robb ML, Birx DL, de Souza MS. Reference Ranges for the Clinical Laboratory Derived from a Rural Population in Kericho, Kenya. *Plos One* 2008;**3**:1-7.
19. Essien EM, Usanga EC, Ayeni O. The normal platelet count and platelet factor 3. Availability in some Nigerian population groups. *Scand J Haematol* 1973;**10**:378-383.
20. Saathoff E, Schneider P, Kleinfeldt V, Geis S, D. H. Laboratory reference values for healthy adults from southern Tanzania. *Trop Med Int Health* 2008;**13**:612-25.