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Full Length Research

HAEMATOLOGICAL PROFILE OF APPARENTLY HEALTHY BLOOD DONORS IN KADUNA STATE, NORTH WESTERN NIGERIA

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This study has been designed and under taken to determine the reference values of some haematological parameters for healthy adult males and females in Kaduna state, Nigeria, and to compare these values with those obtained for other populations in both western and tropical countries. Samples were collected from General Hospital Kafanchan, Yusuf Dantsoho Memorial Hospital, Tudun Wada, Kaduna and Hajiya Gambo Sawaba Memorial Hospital, Zaria representing the southern, central and northern senatorial districts of the state respectively from December, 2013 to December, 2014. The mean values for our male participants were: haemoglobin (HB) concentration; 13.34g/dl, red blood cells (RBC) count; 4.57 x10^{12}/l, haematocrit (PCV) ratio; 41.53 %, white blood cells (WBC) count; 5.92 x10^{9}/l, Platelets (PLT); 206.67 x10^{9}/l, Lymphocytes (LYM); 41.91%, Neutrophils (NEUT); 49.59%, mean cell volume (MCV); 92.81 fl, mean cell haemoglobin (MCH); 29.83 pg and mean cell haemoglobin concentration (MCHC); 32.06. The mean values in the female participants were: haemoglobin (HB) concentration; 12.76g/dl, red blood cells (RBC) count; 4.00x10^{12}/l, haematocrit (PCV) ratio; 38.15%, white blood cells (WBC) count; 6.16 x10^{9}/l, Platelets (PLT); 213.02 x10^{9}/l, Lymphocytes (LYM); 39.22%, Neutrophils (NEUT); 51.12%, mean cell volume (MCV); 99.78fl, mean cell haemoglobin (MCH); 33.72pg and mean cell haemoglobin concentration (MCHC); 33.87g/dl. When compared to their corresponding western mean values, our participants had lower mean values of HB, RBC, PCV and WBC. However, higher mean values of MCV and MCH were recorded for our male and female participants respectively compared to the corresponding mean western values of 86.00fl and 29.50pg. The mean value of mean cell haemoglobin concentration (MCHC) of our female participants was higher than the western value. However, the mean

value of MCHC of our male participants was slightly lower than the western value. The mean values of PLT, LYM and NEUT of our participants irrespective of gender were within the normal ranges of their corresponding western values of 150-400 x10^9/l, 22-44% and 40-70%. When compared with other African countries, the mean value of HB for our participants was the lowest while the PLT was the highest. However, these values are similar to means reported in Zaria northern part of the state and Kano, a neighboring state. Our male participants had significantly higher mean values of PCV (p=0.001) and RBC (p<0.001) but insignificantly higher values of HB (P=0.063), LYM (0.077) and NEUT (0.552). On the other hand, our female participants had significantly higher mean values of WBC (p= 0.001), PLT (p<0.001), MCV (P=0.031), MCH (p=0.001) and MCHC (p<0.001) but insignificantly higher values of WBC (P=0.337) and PLT (P=0.597). This study has established reference values of these haematological parameters in apparently healthy blood donors from different parts of Kaduna state. This will serve as an important tool in the interpretation of laboratory results for clinical management of patients as well as for research purposes.

Key words: Haematological parameters, Apparently healthy, Blood donors, Senatorial district, Kaduna state, Nigeria.

INTRODUCTION

The critical need for the development of normal haematological values specific for every population for interpretation of laboratory test results and provision of quality services in the health care delivery cannot be over emphasized. However, reference values being used in most laboratories in African countries have been obtained from the literature, reagent inserts accompanying the reagent kits or instrument manuals (Koram et al., 2007). These values have been derived from Caucasian populations of industrialized countries (Dosoo et al., 2012). Published literature has indicated that many of the reference values obtained from the developed countries differ significantly from those in most African localities (Lugada et al., 2004; Quinto et al., 2006; Koram et al., 2007; Adetifa et al., 2009; Karita et al., 2009). The Clinical and Laboratory Standards Institute (CLSI) and the International Federation for Clinical Chemistry recommend that each laboratory establishes its own reference values (Solberg, 1987; CLSI, 2008). Studies conducted so far in Nigeria have reported significant differences in normal laboratory ranges within the country and when compared with those of other African countries and industrialized world (Aina et al., 2005; Miri-Dashe et al., 2014). These variations have been attributed to a number of factors including differences in geographical locations, climate, dietary habits, and environmental factors or ethnic and tribal peculiarities (Miri-Dashe et al., 2014). Variables such as the technique, timing of collection, storage of specimens and posture of subjects, though if standardized may be of less effect could also contribute to these observable variations (Lewis, 2006; Isa et al., 2012). Baseline hemoglobin of 12 g/dl and 13 g/dl for potential female and male donors respectively has been stipulated in some countries to ensure donor safety (Marcela et al., 2015). Reference ranges of some haematological parameters for apparently healthy adults have been previously established in Zaria in the northern senatorial district of the state (Isa et al., 2012). However, adoption of these values for interpretation of patients' results in the whole state could be misleading due to afore mentioned reasons. This study was therefore designed to determine the profile of some haematological parameters of apparently healthy blood donors in the three senatorial districts of Kaduna state, Nigeria. This is with a view to providing valuable information for adoption of reference values of these haematological parameters in the state.

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MATERIALS AND METHODS

Study design

A cross-sectional, facility based study was conducted in Kaduna state, north central Nigeria from December, 2013 to December, 2014. Blood samples were collected from General Hospital Kafanchan, Yusuf Dantsoho Memorial Hospital, Tudun Wada, Kaduna and Hajiya Gambo Sawaba Memorial Hospital, Zaria representing the southern, central and northern senatorial districts of the state respectively. These hospitals have facilities for and provide blood transfusion services in their respective senatorial districts.

Study area

Kaduna State is a state in North-western geo-political zone of Nigeria with a population of 6,066.562. It is made up of 23 local government areas which are further grouped into three (3) senatorial districts (north, central and south). It is a metropolitan as well as a cosmopolitan industrialized state with over 80 commercial and manufacturing industries. It is one of the education centers in Nigeria with many colleges and most recognized university in Nigeria. Agriculture is the mainstay of the state with about 80% of the people actively engaged in farming. It is defined by longitude 10°20' N and latitude 9° 03' E. The vegetation characteristic is that of the guinea savanna with scattered trees and shrubs. There are two distinct seasons the wet (rainy) which lasts from April to October and dry season that occurs from November to March. It experiences a rainfall of 1530mm in Kafanchan-Kagoro in the southeast and 1015mm in Ikara/Makarfi districts in the northeastern part of the state (Encyclopedia Britanica, 2012). The map of Kaduna state showing the location of the sampling sites is shown in Figure 1.

Ethical approval

Approval for the research was obtained from the Ethical Committee of the Kaduna State Ministry of Health. Patients' anonymity was maintained and the findings treated with utmost confidentiality.

Questionnaire

Prior to the sample collection, a self designed questionnaire was used to obtain information on some socio-demographic characteristics and study related from consented donors.

Samples collection

A total of 360 apparently healthy male and female blood donors aged between 18 and 65 were recruited for the study after obtaining informed consent from each of them. Apparently healthy blood donors, hospital staff, medical students and individuals presenting at the blood banks of the various hospitals for blood donation were included. Subjects with medical conditions such as diabetes, sickle cell anaemia and asthma as well as subjects who did not consent, had evidence of HIV, HBV and HCV infections, menstruating and pregnant females were excluded.

One hundred and twenty blood samples were collected from General Hospital Kafanchan, Mamman Tsoho Memorial Hospital, Tudun Wada, Kaduna and Hajiya Gambo Sawaba Memorial Hospital, Zaria representing the southern, central and northern senatorial districts of the state respectively. Two milliliters (2ml) of whole venous blood was obtained (out of the 5ml collected from each of the donors by the Phlebotomist for routine preliminary screening and haematological investigations to determine the fitness of the donor) into ethylene diamine tetra acetic acid (EDTA) bottles. Haematological tests were performed on the samples within 48hs according to normal hospital protocol.

Determination of haematological parameters

Full blood/differential count was carried out using the fully automated Sysmex Haematology analyzer manufactured by Sysmex Corporation Kobe, Japan according to the standard

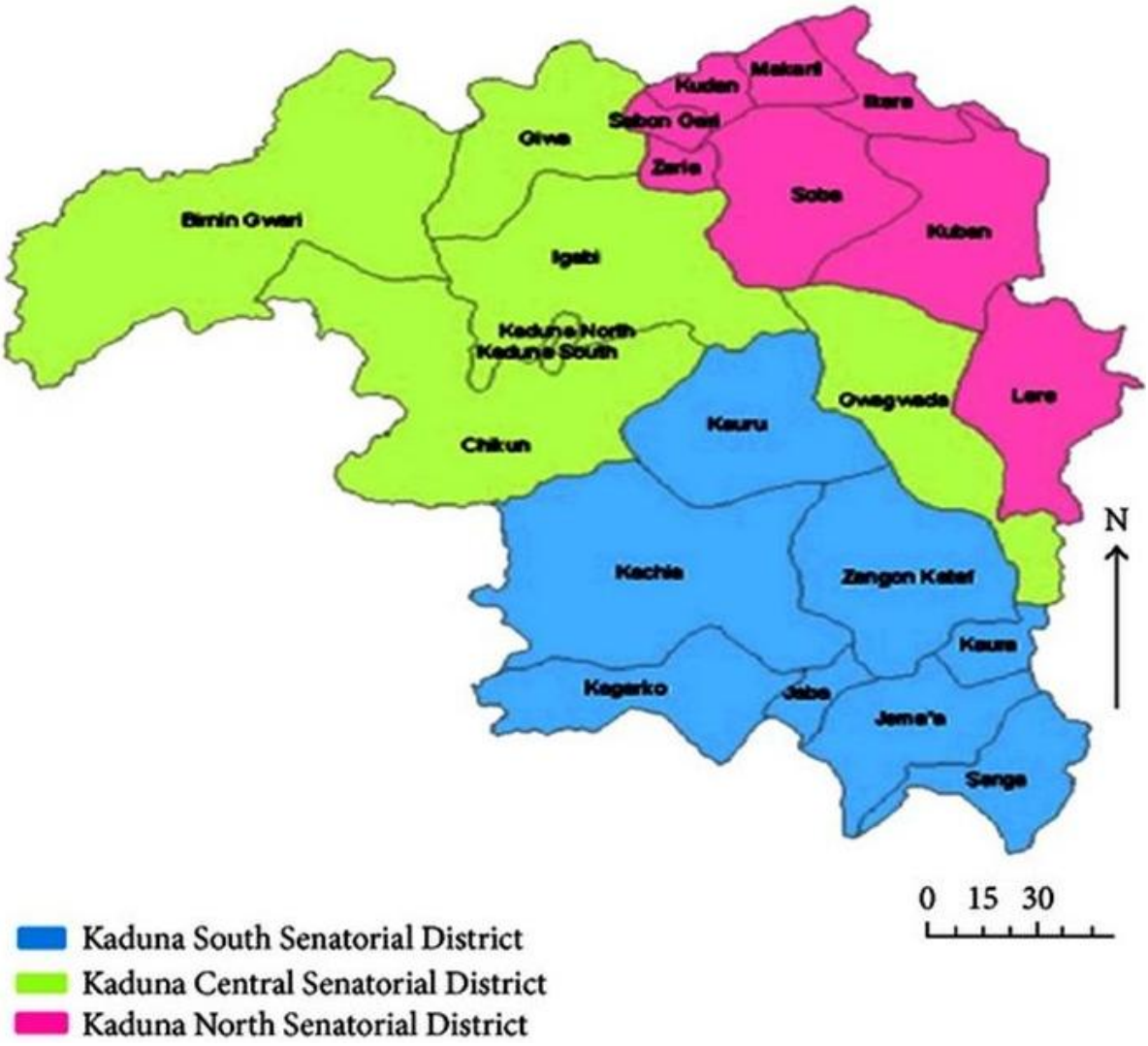

Figure 1. Map of Kaduna state showing the sampling sites.

operating procedure outlined by the manufacturer (Isa et al., 2012).

Statistical analysis

All statistical analyses were carried out using Statistical Analysis System (SAS) and Statistical Package for the Social Sciences (SPSS) version 20. The Pearson Chi-square test was used to determine the associations between the variables at 95% confidence interval while differences in haematological parameters was subjected to analysis of variance (ANOVA). Values of $p \leq 0.05$ were considered significant.

RESULTS

A total of 360 donors comprising of 314(87%) male and 46(13%) female donors were enrolled in the study. Our participants had lower values of Haemoglobin (HB) concentration (13.34 g/dl for males and 12.76 g/dl for females), Red Blood Cells (RBC) Count (4.57 $\times 10^{12}$ /l for males and 4.00 $\times 10^{12}$ /l for females), Haematocrit (PCV) ratio (41.53% for males and 38.15% for females) and White Blood Cells(WBC) count values (5.92 $\times 10^{9}$ /l for males and 6.16 $\times 10^{9}$ /l for females) compared to the western values of HB (15.50g/dl for males and 14.00g/dl for females), RBC (5.5 $\times 10^{12}$ /l for

Table 1. Comparison of the mean values of some haematological parameters of the present study with Western values (Dacie and Lewis, 1991; Hoffbrand et al., 2006; Lewis, 2006).

Haematological parameter	This study		Western values	
	Male (n=314)	Female (n=46)	Male	Female
HB (g/dl)	13.34 ± 0.12	12.76 ± 0.28	15.50	14.00
PCV (%)	41.53 ± 0.34	38.15 ± 0.94	47	42
WBC ($\times10^9$/l)	5.92 ± 0.14	6.16 ± 0.20	7.50	7.50
RBC ($\times10^{12}$/l)	4.57 ± 0.05	4.00 ± 0.14	5.5	4.82
PLT ($\times10^9$/l)	206.67 ± 3.81	213.02 ± 11.30	150-400	150-400
LYM (%)	41.91 ± 0.74	39.22 ± 1.31	22-44	22-44
NEUT (%)	49.59 ± 1.81	51.12 ± 1.82	40-70	40-70
MCV (fl)	92.81 ± 1.05	99.78 ± 4.10	86.00	86.00
MCH (pg)	29.83 ± 0.38	33.72 ± 1.40	29.50	29.50
MCHC (g/dl)	32.06 ± 0.13	33.87 ± 0.45	32.50	32.50

Key: WBC=White Blood Cell, **MCV=** Mean Corpuscular Volume, **MCH=** Mean Corpuscular Haemoglobin, **MCHC =** Mean Corpuscular, Haemoglobin Concentration, **RBC=** Red Blood Cells concentration, **HB** =Haemoglobin concentration, **PCV=** Packed Cell Volume, **PLT**=Platelets, **NEUT** =Neutrophils, **LYM**= Lymphocytes.

males and 4.82×10^{12} /l for females), PCV (47% for males and 42% for females) and WBC (7.50×10^9 /l for both sexes). However, higher values of Mean Volume (MCV) were recorded for our males (92.83 fl) and females (99.78 fl) blood donors compared to the corresponding western values of 86.00 fl (for both sexes). Also, higher values of the Mean Cell Haemoglobin (MCH) were recorded for our male (29.83pg) and female blood donors compared to the western value of 32.50pg (for both sexes). The mean values for Mean Cell Haemoglobin Concentration (MCHC) of our female (33.87g/dl) blood donors was higher than the western value (32.05 pg) for both sexes. However, the MCHC value (32.06pg) of our male blood donors was slightly lower than the western value (32.50 pg) for males and females. The mean values of platelets (PLT) count, Lymphocytes (LYM) and Neutrophils (NEUT) count of 206.67×10^9 /l, 41.91% and 49.59% respectively of our male and 213.02×10^9 /l, 39.22% and 51.12% respectively of our female blood donors were within the normal ranges of the western values of $150\text{-}400\times10^9$ /l, 22-44% and 40-70% for both sexes respectively (Table 1). The Haematocrit (PCV) of 41.53 % and the mean Red Blood Cell (RBC) count were significantly higher in the Male than female blood donors ($p<0.001$). However, the mean values of MCV of the female blood donors were significantly higher than the corresponding values of the males with p-values of 0.031, 0.001 and <0.001 respectively. The mean values of HB and LYM were higher in the male than female blood donors but this difference was not significant ($p=0.063$ and $p=0.077$ respectively). Also, the mean values of WBC, PLT and NEUT were higher in the female than male blood donors donors but not significantly ($p=0.337$, $p=0.597$ and $p=0.552$) as shown in Table 2. There were significant differences in the mean values of all the haematological parameters considered between the three senatorial districts of the state except for NEUT. The northern senatorial district had higher values of PCV ($P<0.001$) and RBC ($P<001$) while higher values of PLT ($p=0.037$) and LYM ($p=0.004$). However, higher values of HB (<0.001), WBC (<0.001), MCV (<0.001), MCH (<0.001) and MCHC (<0.001) were recorded in the southern senatorial district. Also, a higher value of NEUT was recorded in the southern senatorial district but the

Table 2. Mean ± SEM Values of Some Hematological Parameters of the Study Subjects by Gender.

Haematological parameter	Male (n=314)	Female (n=46)	P-value
PCV (%)	13.34 ± 0.12	12.76 ± 0.28	0.063
WBC ($\times 10^9$/l)	41.53 ± 0.34	38.15 ± 0.94	0.001*
RBC ($\times 10^{12}$/l)	5.92 ± 0.14	6.16 ± 0.20	0.337
PLT ($\times 10^9$/l)	4.57 ± 0.05	4.00 ± 0.14	<0.001*
LYM (%)	206.67 ± 3.81	213.02 ± 11.30	0.597
NEUT (%)	41.91 ± 0.74	39.22 ± 1.31	0.077
MCV(fl)	49.59 ± 1.81	51.12 ± 1.82	0.552
MCH(pg)	92.81 ± 1.05	99.78 ± 4.10	0.031*
MCHC(g/dl)	29.83 ± 0.38	33.72 ± 1.40	0.001*
	32.06 ± 0.13	33.87 ± 0.45	<0.001*

Key: WBC=White Blood Cell, **MCV=** Mean Corpuscular Volume, **MCH=** Mean Corpuscular Haemoglobin, **MCHC =** Mean Corpuscular, Haemoglobin Concentration, **RBC=** Red Blood Cells concentration, **HB** =Haemoglobin concentration, **PCV=** Packed Cell Volume, **PLT**=Platelets, **NEUT** =Neutrophils, **LYM**= Lymphocytes.

difference was not significant (p=0.075). This is shown in Table 3.

DISCUSSION

When the values of haematological parameters observed in the present study were compared to values from western populations (Dacie and Lewis, 1991; Hoffbrand et al., 2006; Lewis, 2006), slight differences were observed. Our values of HB, PCV, WBC and RBC were lower than the western values. Similar differences were observed in African adult population compared with western adult populations (Azikiwi et al., 1984; Bradenhorst et al., 1995; Bain, 1996; Hoffbrand et al., 2006). When compared with other African countries, our mean HB was the lowest while our PLT was the highest (Ruiz-Arguelles, 1980; Tsegaye et al., 1999; Menard et al., 2003; Lugada et al., 2004; Adetifa et al., 2009; Kibaya et al., 2008; Saathoff et al., 2008; Kuaviakoe et al., 2011). However, these values are similar to means reported in Zaria northern part of the state (Isa et al., 2012) and Kano, a neighbouring state (Imoru, 2003). The difference in findings of this study and those reported elsewhere (Miale, 1982; Dacie and Lewis, 1991; Wintrobe, 1993; Williams, 1995) could be due to many possibilities. It could be due to geographical variation, dietary factors and bias in selection of the study subjects. For example, the groups studied by Viteri et al. (1972) were highly selected subjects who were hookworm free, had adequate serum iron values; transferrin saturation fraction, serum folate and serum vitamin B12, and thus lower values were obtained in both sex groups than others. On the other hand, Kelly and Munan (1997) from Canada reported lower values in their randomly selected population. The reason for the lower values in this study might be due to variation of the standardization of conditions under which measurements were made. Factors such as altitude, posture and diurnal variations have been reported to make the Haemoglobin concentration, Red Blood Cells count, and Haematocrit Ratio fluctuate (Ekelund et al., 1971; Miale, 1982; Rodger et al., 1987). However, our values of MCV, MCH and MCHC (females) were higher than western values. This is similar to the report of Miri-Dashe et al. (2014). The reason for this observation is unclear and there is need for additional studies to validate these interesting findings.

Table 3. Mean ± SEM Values of Some Hematological Parameters of the Study Subjects by Senatorial Districts.

Parameter /SD	Northern	Central	Southern	F-value
HB (g/dl)	14.06 ± 0.15	11.64 ± 0.15	14.10 ± 0.20	<0.001*
PCV (%)	42.71 ± 0.42	38.16 ± 0.47	42.43 ± 0.66	<0.001*
WBC ($\times 10^9$/l)	6.18 ± 0.15	5.23 ± 0.14	6.44 ± 0.31	<0.001*
RBC ($\times 10^{12}$/l)	5.00 ± 0.05	4.37 ± 0.06	4.13 ± 0.09	<0.001*
PLT ($\times 10^9$/l)	213.63 ± 5.94	214.46 ± 5.98	194.34 ± 6.74	0.037*
LYM (%)	41.15 ± 0.81	44.49 ± 1.09	39.08 ± 1.44	0.004*
NEUT (%)	45.95 ± 1.13	48.75 ± 4.40	54.65 ± 1.43	0.075
MCV(fl)	85.94 ± 0.50	87.51 ± 0.71	107.59 ± 2.62	<0.001*
MCH(pg)	28.37 ± 0.26	26.68 ± 0.26	35.91 ± 0.88	<0.001*
MCHC(g/dl)	32.91 ± 0.17	30.46 ± 0.15	33.50 ± 0.25	<0.001*

* = Significant difference exists at $p \leq 0.01$. Mean values were separated using Duncan's multiple range test. Values with different superscript in the same column are significantly different.

Key: WBC=White Blood Cell, **MCV=** Mean Corpuscular Volume, **MCH=** Mean Corpuscular Haemoglobin, **MCHC =** Mean Corpuscular, Haemoglobin Concentration, **RBC=** Red Blood Cells concentration, **HB** =Haemoglobin concentration, **PCV=** Packed Cell Volume, **PLT**=Platelets, **NEUT** =Neutrophils, **LYM**= Lymphocytes, **SD=** Senatorial District.

When our mean values were compared with previously established values in Zaria (Isa et al., 2012) our values of PCV and PLT were lower in Zaria, while higher values of WBC, MCV, MCH and MCHC were obtained in our study. When our mean values were compared with those from Enugu (Nubila et al., 2014), our values were slightly lower except for WBC and MCH. However, our values of HB, RBC, PCV, WBC, PLT, MCV, MCH, and MCHC were higher than those reported in Benin. These variations could be attributed to differences in geographical locations, climate, dietary habits, and environmental factors or ethnic and tribal peculiarities. (Miri-Dashe et al., 2014). Variables such as the technique, timing of collection, storage of specimens and posture of subjects, though if standardized may be of less effect could also contribute to these observable variations (Lewis, 2006; Isa et al., 2012). Age, sex, frequency of donation, endemicity of parasitic infections such as malaria and helminthic infestations have been reported to contribute to the low red cell indices (De Maeyer and Adiels-Tegman, 1985; Ali et al., 2013).

The red blood cell parameters, RBC, HB and HCT were higher in male blood donors. This difference was significant for RBC (P<0.001) and PCV (P=0.001). This finding is similar to reports from other studies conducted in Africa and also comparable to documentation from the United States of America (Kibaya et al., 2008). On the contrary, PLT, MCV, MCH and MCHC values were higher in women and the difference was significant as compared to men just as reported in other studies (Kibaya et al., 2008; Mine et al., 2011). The reason for these differences may be due to the variations in hormone types and concentrations in the different sexes and the effect of erythropoietin release in response to regular menstruation cross-stimulating megakaryopoiesis. However, the platelet counts are lower when compared to the US derived values and other African studies (Kratz and Ferraro, 2004; Eller et al., 2008; Kibaya et al., 2008; Mine et al., 2011; Zeh et al., 2011). The reason for these lower values is still unclear and may require additional studies but may be due to the diet, genetic

factors or other environmental or genetic factors (Gill et al., 1979; Azikiwi, 1984; Bain, 1996). Despite the fact that the health facilities selected for the study have similar transfusion services practices, there were significant differences in the haematological parameters considered in all the senatorial districts except for NEUT. This may be attributed to population composition (ethnic diversity), genetic composition (genetic diversity), variation in altitude and prevalence of underlying (subclinical) infections (Evans et al., 1999 and Rajab et al., 2005). The decreasing pattern of the RBC from the southern to the northern senatorial districts follows the increasing pattern of malarial parasitaemia prevalence in the state (Garba et al., 2016). This is an indication of the potential effect of malarial parasitaemia on these haematological parameters.

CONCLUSION

This study has established values for haematological parameters in apparently healthy blood donors from different parts of Kaduna state. This will serve as an important tool in the interpretation of laboratory results for clinical management of patients as well as for research purposes. Also, this study should be conducted on a larger number of screened blood donors and in different transfusion centers in the state.

LIMITATION

The study was facility based and therefore may not be a perfect representation of the values of these haematological parameters in the study population. It would be better if we could conduct this study among huge number of subjects, all over the Nigeria.

CONSENT

Written informed consent was obtained from the blood donors.

ETHICAL APPROVAL

All experiments have been examined and approved by the ethical committee of the Kaduna State Ministry of Health.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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