Original Research Article

POPULATION BASED HAEMATOLOGICAL REFERENCE RANGES FOR ADULTS IN NIGERIA: An Update

Abstract

Background: Over the past few decades, the results of laboratory testing have undergone tremendous modification. This is as a result of technology advancements that have improved diagnostic methodology.

Aim :The overarching goal of this study was to provide an update on the adult population of Nigeria's haematological profile while taking into account characteristics that had not been addressed in earlier publications. Materials and Methods: A total of 965 healthy adults participated in this cross-sectional study. They came from Calabar in Cross River State, Gombe State in northeastern Nigeria, and Enugu State in southeast Nigeria. Five millilitres (5 ml) of blood were drawn and well mixed in an EDTA anticoagulant bottle. Using the haematology auto analyzer BC5300 Mindray, the full blood count was carried out on the entire sample of blood.,For serological testing, samples were spurned and their plasma was collected after centrifugation. Individuals were excluded from further research if they tested positive for HIV, HBsAg, malaria parasites, or a positive pregnancy test. Participants provided written informed consent for the collection of samples and their ensuing analysis, and the study was authorized by the University of Nigeria Teaching Hospital Ituku-Ozalla, Enugu, ethical committee.**Results:** The mean value for RDW-CV in adult Nigerians was 13.7, RDW-SD (fl) was 52.74, MPV (fl) was 10.29, PDW was 16.13 and the PCT (mL/L) was 2.20. The platelets showed variations across the ethnic groups, for instance, Efik ethnic group had the lowest value (188±61.6) while the Yoruba population had the highest value (246±77.7) when compared with the population put together (216.84). **Conclusion**: The mean value for RDW-CV, RDW-SD, MPV, PDW and PCT, were captured in this study but we did not record any ethnic or sex variation for them.

Keywords: Hematological profiles, red cell distribution width, mean platelet volume, platelet distribution width and Plateletocrit

Introduction

To interpret the patient's data and make treatment decisions, haematological reference values are used. Due to advancements in laboratory testing tools, chemical reagents, and analysis methods, the accuracy of laboratory testing has considerably increased over time. In the diagnosis and treatment of patients, some of the factors that can be recorded with the improved technique are crucial from a clinical standpoint. For instance, the MPV, which is a marker for bone marrow stress, is also a marker for a number of inherited platelet abnormalities, including Bernard-Soulier Syndrome (GP1BA, GP1BB, GP9, FLNA), Gray Platelet Syndrome (NBEAL 2), MYH9-related diseases (MYH9), and Wiskoh-Aldrich Syndrome (WAS, ARPC1B)[1]. A measure for platelet reactivity known as the mean platelet volume (MPV) has been used to identify novel genetic variants[2].[2].The PDW serves as a measure of platelet size volume variability[3]. In the differential diagnosis of aplastic anemia and immune thrombocytopenic purpura, MPV and PDW are both raised after platelet activation (ITP). A valuable screening test for platelet quantitative abnormalities, platelettocrit (PCT) measures the amount of platelets in the blood and is used to assess whether a patient needs platelet transfusions. It is an independent risk factor in individuals with Mitra stenosis [4]. Because of various factors (confounders), such as age, sex, study centers, etc., these variables exhibit variability. The platelet count has also been linked to ethnic differences [5]Several studies have been conducted in Nigeria to establish reference values for hematopoietic variables. Studies conducted so far in Nigeria have revealed notable variations in the haematological profile when compared to those conducted in other African nations and Europe. This has been explained by varying geographic regions, climatic conditions, environmental factors, and/or ethnic variances. It's interesting that there are some differences in research on haematological reference ranges done in Nigeria [6-8]. The size of the population under study, the ethnic composition of the population under study, the tools and techniques utilized in the lab, and other factors may all play a role in these variations [1,6–11]. Ojor [12], who conducted a screening test for people intending to enlist for military service in Nigeria, completed the most recent study on haematological reference range in Nigeria. The 5parts difference of the white blood cells and the platelet indices were not caught because they were using a 3parts differential haematology analyzer. It is unavoidable that the haematological profile needs to be updated when new technology for blood cell analysis develops

Materials and Methods

Ethical Statement:

The study was authorized by the University of Nigeria Teaching Hospital Ituku-Ethics Ozalla's Research Ethics Committee. All study participants provided written informed consent prior to the collection of samples and their analysis.

Study population

There were 965 healthy individuals in this cross-sectional investigation. The research populations were drawn from Calabar in Cross River State, Enugu in Cross River State, and Gombe in Northeastern Nigeria. Those having a history of fever, recent use of antimalarial medications, recent worm treatment, a history of cancer or cancer treatment, or any other underlying medical condition were excluded from the trial.

Sample collection and Laboratory Investigations:

Five milliliters (5 ml) of blood were drawn and well mixed in an EDTA anticoagulant bottle. Each day, between the hours of 8 am and 2 pm, the subjects' anti-coagulated samples were collected. Using the haematology auto analyzer BC5300 Mindray China, the whole blood count was carried out on the entire sample of blood. After centrifuging the samples, plasma was extracted, and the plasma samples were used for serological testing. The quick test kits Determine1, Unigold1, and Stat-Pak1, HBsAg screening kit, were used to perform HIV-1 and HIV-2 tests. LabACON1 kits were used to test for pregnancy (Citus Diagnostic Inc1, British Columbia, Canada). A blood slide that tested positive for the malaria parasite was used to define malaria parasite infection. Giemsa-stained blood smears of various thicknesses were made and the malaria parasite was microscopically inspected.All samples were analyzed and processed within 4 hours of collection.

Statistics

Individuals were excluded from further research if they tested positive for HIV, HBsAg, malaria parasites, or a positive pregnancy test. The Statistical Package for Social Sciences (SPSS), International Business Machine (IBM) Statistical software, (IBM SPSS Statistics) for Windows, version 23.0. Armonk, NY was used for statistical analysis. For the categorical variable's presentation, frequencies and percentages were employed. Means and standard deviation were used to express continuous variables. ANOVA and an independent-sample t-test for significant differences (p.05) were both applicable.

Results

The characteristics of the study population are as shown in table I. In table II Kruskal Wallis test was also used to compare the difference in haematological parameters among the selected ethnic group. There was a statistically significant difference ($p< 0.05$) in the red blood cell indices (MCV and MCHC g/L) and platelet count among the ethnic groups. The MCV values of Efik (82.0) participants was significantly lower when compared to that of Igbo (86.1, $p=0.039$) and Fulani (88.1, $p=0.007$) participants. The MCHC of Efik subjects was significantly higher than those of Igbo, Fulani and Hausa ethnic groups while their platelet count was significantly lower when compared to subjects from Igbo and Yoruba ethnic groups. However, other haematological parameters showed no significant difference ($p>0.05$) among the ethnic group

TABLE I: CHARACTERISTICS OF STUDY POPULATION

Age	25±6.7(16-52)
Sex	
Females	380(39%)
Males	585(61%)
Ethnic groups	
IGBO	210(21.8%)
EFIK	198(20.5%)
FULANI	150(15.5%)
HAUSA	206(21.3%)
YORUBA	201(20.8%)
Blood Groups	
A+ve	193(20%)
O+ve	560(58%)
B+ve	151(15.7%)
O-ve	32(3.3%)
AB+ve	19(2%)
B-ve	10(1%)

TABLE 2: DIFFERENCE IN MEANS Of HEMATOLOGICAL PARAMETERS ACROSS ETHNIC GROUPS

	Total Population(965)	Yoruba n= 201	Igbo N=210	Efik N=198	Fulani N=150	Hausa N=206	P value
WBCX10^9/l	5.12	5.10 ± 1.03	5.14 ± 1.08	5.19 ± 1.19	5.04 ± 1.24	4.89 ± .84	0.90
NEU%	0.44	0.42 ± .07	0.45 ± .09	0.43 ± .11	0.43 ± .08	0.46 ± .05	0.23
LYM%	4.49	0.48 ± .06	0.46 ± .08	0.47 ± .12	0.48.08	0.45 ± .06	0.54
MON%	0.03	0.03 ± .02	0.03 ± .02	0.03 ± .02	0.03 ± .02	0.04 ± .03	0.47
EOS%	0.04	0.04 ± .02	0.04 ± .03	0.05 ± .04	0.05 ± .04	0.039 ± .03	0.27
BAS%	0.04	0.06 ± .05	0.06 ± .03	0.05 ± .04	0.01 ± .00	0.04 ± .03	0.11
NEU#X10^9/L	2.33	2.12 ± .56	2.38 ± .71	2.26 ± .83	2.21 ± .71	2.23 ± .44	0.33
LYM#X10^9/L	2.35	2.46 ± .64	2.33 ± .60	2.49 ± .73	2.39 ± .61	2.20 ± .47	0.56
MON#X10^9/L	0.16	0.17 ± .13	0.15 ± .11	0.17 ± .12	0.15 ± .11	0.19 ± .12	0.61
EOS#X10^9/L	0.30	0.81 ± .67	0.71 ± .57	0.39 ± .23	0.84 ± .63	0.24 ± .24	0.30
BAS#X10^9/L	0.08	0.51 ± .32	0.28 ± .17	0.33 ± .21	0.03 ± .02	0.255 ± .11	0.06
RBCX10^12/L	4.86	5.04 ± .72	4.80 ± .62	5.04 ± .68	5.03 ± .61	4.93 ± .59	0.13
HGB g/L	131.26	135 ± 16.67	130 ± 15.20	132 ± 16.24	138 ± 13.47	130 ± 16.96	0.29
HCT	0.40	0.40 ± .12	0.40 ± .07	0.40 ± .08	0.44 ± .05	0.38 ± .11	0.12
MCV Fl	85.51	85.3 ± 6.08	86.1 ± 6.77	82.0 ± 8.16	88. 1 ± 4.86	83.62 ± 7.36	0.01 **
MCH pg	27.56	26.9 ± 2.19	27.9 ± 6.71	26.4 ± 2.70	27.6 ± 1.56	26.4 ± 2.42	0.12
MCHC g/L	315.63	316 ± 7.8	315 ± 15.09	323 ± 5.8	310 ± 18.9	316 ± 7.9	0.000 **
RDW-CV	0.14	0.13 ± .01	0.14 ± .03	0.15 ± .08	0.13 ± .01	0.16 ± .07	0.29
RDW-SD fL	52.75	52 ± 4.1	53 ± 4.2	53 ± 3.9	54 ± 2.7	52 ± 5.1	0.56
PLTX10^9/L	216.84	246 ± 77.7	219 ± 67.9	188 ± 61.6	214 ± 60.8	227 ± 80.6	0.03 **
MPV fL	10.29	10.2 ± .72	10.3 ± .87	10.5 ± .96	10.1 ± .57	10.3 ± .91	0.32
PDW	16.13	16.1 ± .43	16.1 ± .42	16.3 ± .44	16.1 ± .45	16.1 ± .46	0.10
PCT mL/L	2.20	2.50 ± .72	2.23 ± .63	1.95 ± .59	2.14 ± .58	2.30 ± .76	0.06

WBC – White blood cell, PLT – Platelet, MPV – Mean platelet volume, PDW – Platelet volume distribution width, PCT-platelet concentration, RDW-SD- red cell distribution width standard deviation, RDW-CV- red cell distribution width co-efficient of variation, MCHC- mean corpuscular haemoglobin concentration, MCH- mean cell haemoglobin, MCV-mean cell volume, HCT-hematocrit, HBG- haemoglobin concentration, RBC- red blood cell count, BASO- Basophils, EOS-Eosinophil, MON-Monocytes, LYM-Lymphocytes, NEU-Neutrophils.

TABLE 3: DIFFERENCE IN MEANS OF HEMATOLOGICAL PARAMETERS ACROSS GENDER

Haematological Parameters	Male n= (585)	Female n=(380)	P-value
WBCX10^9/L	5.00 ± 1.01	5.34 ± 1.20	0.01
NEU%	0.45 ± .08	0.45 ± .09	0.49
LYM%	0.46 ± .08	0.45 ± .09	0.28
MON%	0.03 ± .02	0.03 ± .02	0.18
EOS%	0.04 ± .04	0.04 ± .03	0.96
BAS%	0.04 ± .03	0.22 ± .04	0.52
NEU#X10^9/L	2.26 ± .64	2.45 ± .81	0.04**
LYM#X10^9/L	2.31 ± .60	2.43 ± .64	0.78
MON#X10^9/L	0.16 ± .11	0.15 ± .12	0.38
EOS#X10^9/L	0.62 ± .60	0.62 ± .47	0.97
BAS#X10^9/L	0.27 ± .16	0.73 ± .20	0.14
RBCX10^12/L	5.01 ± .62	4.60 ± .56	0.00**
HGB g/L	134 ± 15.5	124 ± 13.1	0.000**
HCT	0.41 ± .09	0.391 ± .04	0.02**
MCV Fl	85.5 ± 6.8	85.9 ± 7.3	0.37
MCH pg	27.02 ± 2.17	28.51 ± 9.14	0.21
MCHC g/L	316 ± 12.8	315 ± 16.6	0.46
RDW-CV	0.13 ± .03	0.14 ± .06	0.23
RDW-SD fL	53 ± 3.8	53 ± 4.7	0.861
PLTX10^9/L	216 ± 71	219 ± 64	0.21
MPV fL	10.3 ± .83	10.3 ± .89	0.44
PDW	16.2 ± .42	16.1 ± .43	0.068
PCT mL/L	2.19 ± .66	2.23 ± .59	0.081

Data displayed as mean ± standard deviation, level of significance < 0.05. An independent- sample t-test was conducted to compare haematological parameters in males and female

TABLE 4: SHOWS THE MEAN VALUES OF THE PRESENT STUDY COMPARING IT WITH THE MEAN OF PREVIOUS STUDIES

	Present Study (965 adults)	Wadzanai P.S et al., 2016 (2359 subjects in zimbabwea)	Isa A.H. et al., 2019 (184 adults in Nigeria)	Chisale M.R et al., 2015 (105 subjects in Malawi)	Timzing M.D. et al., 2014 (383 subjects in Nigeria)	Ojor Ayemoba et al., 2019 (7,797 adults in Nigeria)	David K.D. et al., 2012 (691 subjects in Ghana)	Joseph O.M. et al., 2016 (1449 adults Uganda)
WBCX10^9/L	5.12	5.1	5.4	4.3	4.4	5.9	5.4	4.8
NEU%	44.7	44.2	-	-	53.5	45.5	48.5	43
LYM%	40	43	-	-	39	41	42.3	43.9
MON%	6.2	8.5	-	-	5.8	-	8.4	6.5
EOS%	0.04	3.6	-	-	1.5	-	-	3.2
BAS%	0.02	0.4	-	-	0.09	-	-	1.0
NEU#x10^9/L	2.33	2.28	-	2.1	-	2.6	2.7	2.0
LYM#x10^9/L	2.35	2.15	-	1.7	-	2.4	2.1	2.09
MON#x 10^9/L	0.2	0.42	-	0.4	-	-	0.4	0.31
EOS#x10^9/L	0.2	0.17	-	0.1	-	-	-	0.15
BAS#x10^9/L	0.08	0.02	-	0.0	-	-	-	0.04
RBCx10^12/L	4.86	5.2	-	5.1	5.2	5.5	4.57	4.63
HGB g/L	13.26	14.7	-	14.3	14.2	14.8	13.1	13.6
HCT	44.4	45.3	47	43.2	44.19	46	39.4	40.6
MCV Fl	85.51	88.1	85	82	85.5	84	87	87
MCH pg	27.56	28.5	31	24	27.6	27	28.6	29.9
MCHC g/L	31.63	32.4	-	31	32.18	32	33.1	33.4
RDW-CV	13.7	-	13.5	-	-	-	13.5	-
RDW-SD fL	52.74	-	-	-	-	-	-	-
PLTX10^9/L	216.84	251.1	272	195	216.40	218	216.1	220
MPV fL	10.29	10.3	-	-	-	-	10.3	-
PDW	16.13	-	-	-	-	-	15.7	-
PCT mL/L	2.20	-	-	-	-	-	-	-

WBC – white blood cell, NEU– Neutrophil, Lym-Lymphocyte, Mon-Monocyte, Eos- Eosinophil, Bas- Basophils, PLT – Platelet, MPV – Mean platelet volume, PDW – Platelet distribution width, RBC-red blood cell, HGB-haemoglobin,HCT- Haematocrit, MCV- mean cell volume, MCHC- mean cell haemoglobin concentration, MCH- Mean cell haemoglobin, PCT- Platelet crit.

Discussions

Certain previously unquantifiable factors related to blood cells have become quantifiable as technology advances. For instance, research that reported on haematological variables initially began with manual

blood cell counts, then moved on to automated counts that divided the white blood cells into three parts, and finally five parts differentials. Technology advancements have also improved the characterization of red blood cells, platelets, and other blood components in addition to white blood cells. We have made an effort to offer a thorough update on the haematological profile of adult Nigerians in this study.

This study included more interesting factors for blood counts by performing a 5 parts differential count of the blood cells. For the people of Nigeria, these have not been recorded in reference ranges. As compared to the value for the entire population, the MCV (fl) test showed that the Efik population had the lowest value (82.08.16) and the Fulani ethnic group had the highest value (88.14.86) for red cell indices and platelet counts (85.51).Second, as compared to the entire population, the MHCH recorded low values for the Fulani population (31018.9) and high values for the Efik ethnic group (3235.8). The variances across the ethnic groups also affected the platelets; for example, as compared to the entire population, the Yoruba ethnic group had the greatest value (24677.7) and the Efik ethnic group had the lowest value (18861.6). (216.84). The current study supports the idea that there is variation in the hematologic profile across ethnic and geographic zones by confirming the existing data and adding to it.

Moreover, there were notable disparities in the gender-specific means of some of the haematological variables. As seen, the male subjects' neutrophil absolute count was 2.260.64 while the female subjects' was 2.45.08; the male subjects' RBCx1012/l count was 5.010.62 while the female subjects' was 4.600.56; and the male subjects' HCT value was 0.410.09 while the female subjects' was 0.390.04. this study showed that, whereas more recent research [15]did not notice such changes in platelet count for the sexes, earlier studies [13][14] reported differences in platelet count for the sex, supporting the significance of technological advancements to laboratory methodologies.This is unquestionably a result of improvements in laboratory analytical techniques for hematological profiles over time, from manual cell counts to complete automation. Despite the fact that some variables were still not included in that study, the discrepancies between the haematological parameters obtained using the manual and automated methods have been reported.

The factors included to the haematological profile in table 4 are interesting. For instance, variables like the RDW-CV, RDW-SD fL, MPV fL, PDW and PCT mL/L were not included in the earlier research. When compared to other previous research, thisstudy found that the variable collected was within the same range. It's a positive development that most of the haematological variables reported in this study were within the same bounds as those reported in the most recent study [12]. It is noteworthy to note that the new factors that were included in this study and were obtained using more sophisticated techniques had no effect on the results of the variables that had already been analyzed.

Limitations of the study:

This study assessed the auto haematology analyzer's output in order to update these parameters in light of technological advancement. But we must also admit that we did not assess how well these analyzers performed under pathological circumstances.

Conclusion:

The advancement of technology has made it possible to identify and consider factors that were previously difficult or impossible to detect, therefore necessitating the updating of prior data and analysis. In this study, the mean values for RDW-CV, RDW-SD, MPV, PDW, and PCT were measured, but information on any differences in these values based on ethnicity or sex was not collected.

Ethical statement: The Ethical Committee of the University of Nigeria Teaching Hospital Ituku-Ozalla, Enugu, approved the study. We obtained written informed consent for the collection of samples and their subsequent analysis from all study participants.

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