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Reference Ranges of Haematological Parameters in Apparently Healthy Elderly Persons in Nnewi Metropolis, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Backgorund: Haematological parameters are important constituent of blood used to monitor immune system, disease progression and therapeutic response. This can be achieved through porper reference values in clinical laboratory.
Aim: This study was aimed at determining reference values of haematological parameters in apparently healthy elderly persons in Nnewi and compared with the local reference values.
Study Design: This was a comparative study
Duration of Study: The study lasted for a period of one year between Januray to December, 2020.
Methodology: This study involved a total of 105 apparently healthy elderly persons aged 60 years. Full blood counts (FBC) were determined using five part haematological analyser by Mindray, Germany. Data were expressed as percentiles, mean and standard deviation. The differneces in gender was determined using using independent t-test and one way ANOVA was used to compare the means between different age groups and BMI

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Results: The study established reference ranges of WBC, lymphocyte, neutrophil, eosinophil, monocyte, basophil, RBC, Hb, HCT, MCHC, MCH, MCV, RDW-CV RDW-SD, Platelet count, MPV, PDW and Plateletcrit for the elderly in the Nnewi metropolise. Neutrophil, monocyte, HCT, MCH and MCV were lower than the local used reference ranges used in Nnewi. Lymphocyte, monocyte, RBC, MCHC, MCH, RDW-CV, RDW-SD MPV and PCT were higher than the local used reference ranges in Nnewi. PCV and Hb were significantly higher in males than females (p=<0.001). Monocyte increased with increase in BMI (p=<0.001).
Conclusion: In conclusion, normal reference values obtained in this study notably vary with the local reference ranges used in Nnewi. There is need for each locality to have separate reference ranges for the elderly for their proper diagnosis and management.

Keywords: Reference; ranges; haematological; parameters; elderly; Nnewi; Nigeria.

1. INTRODUCTION

Haematological parameters are quantifiable constituents of blood like erythrocytes and its indices, leukocytes and platelets. These blood components originate from the haemopoeitic stem cell, they occupy the entire capacity of the bones at birth but it is been replaced with fatty marrow with increase in age, thereby affecting these blood parameters [1]. Based on the occupation of the bone marrow by fatty marrow as a result of ageing, different reference ranges could be seen for different age groups [2]. The assessment of haematological parameters is very necessary because, they are important proxy indicators useful in the assessment of immune status, therapeutic purposes and monitoring of disease progression and treatment outcome for proper patient management. The developmental stages of life vary directly with basic biological variables of age and sex independently. In pursuant of effective health care through accurate diagnosis, haematological parameters are routinely assessed [1].

The term 'Elderly' is applied to those individuals belonging to age 60 years and above, who represent the fastest growing segment of populations throughout the world [3,4]. Elderly are those in old age, that's later part of life; the period of life after youth and middle age [5]. They have two common medical findings; anaemia and frailty. Anaemia in older persons is associated with increased physical impairment, frailty, cognitive decline, depression and mortality [6]. The elderly is expected to have a higher prevalence of anaemia compared to the general population, as longevity is associated with a variety of physiological dysfunctions, chronic and inflammatory diseases, and occasionally inadequate diet that lowers reserves and the availability of iron [7]. Improper reference values may have contributed to the misdiagnoses [8]. Several factors including modifiable life lifestyle (dietary patterns, attitude) and non-modifiable (such as age, sex) also affect haematological parameters [1].

Reference range is the basis for results interpretation and patient management; it is highly significant in diagnostic accuracy [9]. This is the most common decision support tool used for interpretation of numerical pathology reports [10]. There are fatty changes in bone marrow of the elderly as they advance in age. This has made clinicians to be confronted with the problem of ''normal'' or ''physiological'' values in aged subject, despite considerable amount of data published concerning the haematological status of the aged [11]. It is a well-established practice to determine the normal reference values in different parts of the world because of geographical, ethnic and other variations. Due to variation in topographical, social, and health status, it is unsafe to use reference ranges from a different setting/population (race and ethnicity). Other causes of variation in reference ranges include body mass index, sex, age, genetics, altitude, and environmental factors like pathogens [9]. Studies have shown differences in hematological parameters among different populations [1,12,11,13]. However, in Nnnewi there are no reference values for the elderly. The same values are used for all adults that are both old and young. This has led to misdiagnosis, knowing fully well that the elderly has great physiological difference with young adults. Therefore, this study was set out to establish separate reference ranges of haemtological parameters in apparently healthy elderly persons in Nnewi, Nigeria. This study would possibily show the differences in the established and local reference values, highlight need to have separate values for the elderly and show age, gender and BMI differences on the studied parameters. Furthermore, this study would

expose gender, age and body mass index (BMI) differences FBC in the test subjects. The established reference values will help in proper diagnosis, treatment and management of the elderly on anaemia and blood related disorders.

2. MATERIALS AND METHODS

2.1 Study Design

This was a comparative study that involved apparently healthy elderly persons aged 60 years and above in Nnewi metropolises.

2.2 Study Area

The study was conducted in Nnewi metropolises. Nnewi on the other hand is the second largest city in Anambra State in South-east Nigeria. Nnewi as a metropolitan city encompasses two Local Government Areas, Nnewi North and Nnewi South. Nnewi North comprised of Otolo, Uruagu, Umudim and Nnewichi while Nnewi South comprised of Ukpo, Utu, Ezinifite, Orsumoghu, Unubi, Ekwulimili, Amichi. Both Nnewi South and North are refered as Nnewi metropolis. As of 2006, Nnewi has an estimated population of 391,227 according to the Nigerian census. The city spans over 1,076.9 square miles (2,789 km2) in Anambra State. Dimensionally, Nnewi has an edge over all other units, being recognized by the 1953 census figures as the largest inland town of all others in the Eastern states of Nigeria [14].

2.3 Study Site

The study was carried out in Nnewi metropolises. Laboratory analysis for haematological parameters were assayed at Haematology Departments of Nnamdi Azikiwe University Teaching Hospital (NAUTH),

2.4 Study Population

Apparently healthy in this context as defined by Azuonwu *et al*. [1] are those in good health condition with no observable signs and symptoms of ill health and free from HIV. The data were collected through interviewers administered questionnaire. Factors that may alter haematological values such as smoking were sought as basis for exclusion from the study. According to Tsang *et al.* [15], current smokers were those currently smoking manufactured cigarettes, hand-rolled cigarettes, cigars, or pipe tobacco. Ex-smokers were those who had ever regularly smoked cigarettes, cigars, or a pipe. Blood samples were collected from those that met the inclusion criteria for assay of parameters under study. Anthropometric parameters were also taken. Height was measured to the nearest 0.1 centimetre with a portable stadiometer [16]. Weight of respondent was measured with a portable electronic weight scale in kilograms with light clothing (without shoes) to the nearest 0.1kg [17]. Body Mass Index (BMI) was calculated from the weight and height values for each individual using the formular = weight (kg)/Height (m) ^{2} [18]. BMI was classified as follows: underweight (BMI <18.5kg/m^2), normal weight (BMI of 18.5-24.9 kg/m^2), overweight (BMI of 25-29.9 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) [19].

2.5 Sample Size Calculation

Sample size was determined with G-Power 3.0 software.

2.6 Recruitment of Participants

The test subjects were recruited from Nnewi metropolises in communities and markets through medical outreach. They were consecutively recruited until a required sample size was achieved.

2.7 Inclusion Criteria and Exclusion Criteria

Apparently healthy elderly persons (≥ 60 years) living in Nnewi, within the age limit who were willing to give informed consent. Those not on iron medications or supplements like erythropoiesis-stimulating agents and colony-stimulating factors (erythropoiesis enhancer) and HIV negative in addition to having no history of blood transfusion in the last six months. HIV sero-reactivity was determined using determine rapid kit according to manufacturer's instruction. Participants were categorised as HIV non-reactive when there was no positive reaction on the kit. And those that did not meet the inclusion criteria were excluded.

2.8 Sampling Method

The sampling method adopted was convenience sampling method.

2.9 Sample Collection

A blood sample (2ml) was withdrawn from each participant with minimal stasis from the

antecubital vein using dry, sterile disposable 2ml syringe and transferred into the tube containing the anticoagulant, ethylene diamine tetra-acetic acid (EDTA) and was used for the determination of the FBC.

2.10 Laboratory Procedure

2.10.1 Determination of FBC (Mindray auto haematology analyzer, HM-500X, 2016, Germany)

The EDTA blood was used to determine FBC using automated five parts haematology analyser. The autoanalyser was switched on. And sample ID was entered and checked on the touch screen display. The sample was mixed gently by inverting it at least three times. Then, the tube was held up for probe of the sample. The sample was moved close to the probe to aspirate the sample. Then, the machine analysed and displayed the results on the screen which was printed out.

2.11 Statistical Analysis

Data were collected into excel spread sheet and transferred into the data editor of Statistical Package for Social Sciences (SPSS, Version 23, Inc., Chicago USA) software and were analysed. Mean and standard deviation of the haematological parameters were determined. 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 variables in this study. Age and BMI differences were determined using one way ANOVA. Error probability was set at p-value < 0.05.

3. RESULTS

3.1 FBC Reference Ranges of the Test Subjects

Established reference ranges of FBC parameters in Nnewi were as follows: WBC (10^9/L) (3.9 – 8.89), Lymph (10^9/L) (0.88 – 4.83), Neut (10^9/L) (1.52 – 3.76), Eosino(10^9/L) (0.17 – 0.38), Mono (10^9/L) (0.10 – 1.33), Baso (10^9/L) (0.00 – 0.00), RBC (10^{12}/L) (3.33 – 5.68), Hb (g/dl) (11.47 – 14.9), HCT (%) (34.46 – 45.77), MCHC (g/dl) (31.40 – 37.03), MCH (pg) (24.5 – 34.66), MCV (fL) (76.50 – 104.97), RDW-CV (%) (11.87 – 18.10), RDW-SD (fL) (41.80 – 63.10), PLT (10^9/L) (117.45 – 302.10), MPV (fL) (9.63 – 11.30), PDW (15.20 – 16.84), PCT (%) (0.142 – 0.317).

3.2 FBC Reference Ranges of the test Subjects and Local Reference Values in Nnewi

WBC, eosinophil, basophil counts, Hb and PDW were within the local used reference ranges in Nnewi. Neutrophil, monocyte, HCT, MCH and MCH were lower than the local used reference ranges in Nnewi. Lymphocyte, monocyte, RBC, MCHC, MCH, RDW-CV, RDW-SD MPV and PCT were higher than the local used reference ranges in Nnewi.

3.3 FBC (mean ± SD) of the Test Subjects Based on Gender

Comparison of the Eosino (10^9/L) in different gender showed female eosinophil was significantly higher than male (p=0.026). Also, Mono (10^9/L) of the subjects in different gender was significantly higher in male than female (p=0.034). Hb (g/dl) of the subjects in different gender in was significantly higher in male than female (p= <0.001). HCT (%) of the subjects in different gender in was significantly higher in male than female (p= <0.001).

3.4 Red Cell Indices, Platelet and Platelet Indices (mean ± SD) of the Study Subjects Based on Gender

MCV (fL) in different gender was significantly higher in male than female (p=0.039). PDW of the subjects in different gender was significantly higher in male than female (p=<0.001).

3.5 FBC (mean ± SD) of the Test Subjects Based on Age

Comparison Hb (g/dl) of the subjects in different age groups in Nnewi showed statistical difference (p= 0.010). The difference in Hb was observed between groups 65-69 vs 70-74. HCT (%) in different age groups showed statistical difference (p=0.003). This was shown in between groups. There was significant decrease in HCT of those in age group 70-74 when compared with groups 60-64 and 65-69.

Table 1. Reference values of FBC in the test subjects

Parameters	Mean ± SD	Median	2.5th - 97.5th Median percentile
WBC (10^9/L)	5.44 ± 1.44	5.16	3.9 – 8.89
Lymph (10^9/L)	2.61 ± 0.06	2.11	0.88 – 4.83
Neut (10^9/L)	2.24 ± 0.08	2.56	1.52 – 3.76
Eosino(10^9/L)	0.13 ± 0.01	0.10	0.17 – 0.38
Mono (10^9/L)	0.47 ± 0.03	0.40	0.10 – 1.33
Baso (10^9/L)	0.00 ± 0.00	0.00	0.00 – 0.00
RBC (10^{12}/L)	4.20 ± 0.46	4.15	3.33 – 5.68
Hb (g/dl)	12.96 ± 0.96	12.80	11.47 – 14.9
HCT (%)	39.72 ± 2.97	39.40	34.46 – 45.77
MCHC (g/dl)	32.85 ± 1.29	32.60	31.40 – 37.03
MCH (pg)	30.90 ± 2.17	30.90	24.5 – 34.66
MCV (fL)	94.60 ± 6.28	94.30	76.50 – 104.97
RDW-CV (%)	14.35 ± 1.32	14.20	11.87 – 18.10
RDW-SD (fL)	50.96 ± 5.14	50.20	41.80 – 63.10
PLT (10^9/L)	196.23 ± 44.75	196.00	117.45 – 302.10
MPV (fL)	10.54 ± 1.88	10.50	9.63 – 11.30
PDW	15.96 ± 0.37	15.90	15.20 – 16.84
PCT (%)	0.227 ± 0.045	0.232	0.142 – 0.317

Key: WBC = White Blood Cell, Lymph = Lymphocyte, Neut = Neutrophil, Eosino = Eosinophil, Mono = Monocyte, Baso = Basophil, RBC = Red blood Cell, Hb = Haemoglobin, HCT = Haemotocrit, MCHC = Mean Corpuscular Haemoglobin Concentration, MCH = Mean Corpuscular Haemoglobin, MCV= Mean Corpuscular Volume, RDW-CV = Red Cell Distribution Width- coefficient of variation, RDW-SD = Red Cell Distribution Width-Standard Deviation, PLT = Platelet Count, MPV = Mean Platelet Volume, PDW = Platelet Distribution Width, PCT = Plateletcrit

Table 2. FBC Reference ranges of the test subjects and local reference values

Parameters	Test Subjects	Local Values in Nnewi
	Lower limit – Upper limit	Lower limit – Upper limit
WBC (10^9/L)	3.9 – 8.89	4.00 – 10.00
Lymph (10^9/L)	0.88 – 4.83	0.80 – 4.00
Neut (10^9/L)	1.52 – 3.76	2.00 – 7.00
Eosino(10^9/L)	0.17 – 0.38	0.02 – 0.50
Mono (10^9/L)	0.10 – 1.33	0.12 – 1.20
Baso (10^9/L)	0.00 – 0.00	0.00 – 0.10
RBC (10^{12}/L)	3.33 – 5.68	3.50 – 5.50
Hb (g/dl)	11.47 – 14.9	11.00 – 16.00
HCT (%)	34.46 – 45.77	37.00 – 54.00
MCHC (g/dl)	31.40 – 37.03	32.00 – 36.00
MCH (pg)	24.5 – 34.66	27.00 – 34.00
MCV (fL)	76.50 – 104.97	80.00 – 100.00
RDW-CV (%)	11.87 – 18.10	11.00 – 16.00
RDW-SD (fL)	41.80 – 63.10	35.00 – 56.00
PLT (10^9/L)	117.45 – 302.10	100.00 – 300.00
MPV (fL)	9.63 – 11.30	7.00 – 11.00
PDW	15.20 – 16.84	9.00 – 17.00
PCT (%)	0.142 – 0.317	0.108 – 0.282

Key: WBC = White Blood Cell, Lymph = Lymphocyte, Neut = Neutrophil, Eosino = Eosinophil, Mono = Monocyte, Baso = Basophil, RBC = Red blood Cell, Hb = Haemoglobin, HCT = Haemotocrit, MCHC = Mean Corpuscular Haemoglobin Concentration, MCH = Mean Corpuscular Haemoglobin, MCV= Mean Corpuscular Volume, RDW-CV = Red Cell Distribution Width- coefficient of variation, RDW-SD = Red Cell Distribution Width-Standard Deviation, PLT = Platelet Count, MPV = Mean Platelet Volume, PDW = Platelet Distribution Width, PCT = Plateletcrit

Table 3. FBC (mean ± SD) of the test subjects based on gender

Parameter	Male n=83	Female n=22	t-value	p-value
WBC (10^9/L)	5.3 ± 1.5	5.5 ± 1.4	-0.490	0.625
Lymph (10^9/L)	2.5 ± 0.6	2.7 ± 0.6	-1.317	0.191
Neut (10^9/L)	2.2 ± 0.8	2.3 ± 0.9	-0.426	0.671
Eosino (10^9/L)	0.1 ± 0.0	0.1 ± 0.1	-2.264	0.026*
Mono (10^9/L)	0.6 ± 0.4	0.4 ± 0.3	2.149	0.034*
RBC (10^{12}/L)	4.3 ± 0.4	4.2 ± 0.5	1.465	0.146
Hb (g/dl)	13.7 ± 1.0	12.8 ± 0.9	4.030	<0.001*
HCT (%)	41.9 ± 3.4	39.1 ± 2.6	4.201	<0.001*

**p< 0.05 is significant*

Key: WBC = White Blood Cell, Lymph = Lymphocyte, Neut = Neutrophil, Eosino = Eosinophil, Mono = Monocyte, RBC = Red blood Cell, Hb = Haemoglobin, HCT = Haemotocrit

Table 4. Red cell indices, platelet and platelet indices (mean ± SD) of the study subjects based on gender

Parameter	Male n=22	Female n=83	t-value	p-value
MCHC (g/dl)	32.6 ± 0.5	32.9 ± 1.4	-0.940	0.349
MCH (pg)	31.7 ± 1.6	30.7 ± 2.3	1.896	0.061
MCV (fL)	97.0 ± 4.6	94.0 ± 6.5	2.088	0.039*
RDW-CV (%)	14.0 ± 1.0	14.4 ± 1.4	-1.347	0.181
RDW-SD (fL)	51.3 ± 3.6	50.9 ± 5.5	0.391	0.697
PLT (10^9/L)	182.2 ± 34.6	199.9 ± 46.6	-1.665	0.099
MPV (fL)	11.8 ± 1.0	15.3 ± 18.9	-0.843	0.401
PDW	16.2 ± 0.2	15.9 ± 0.4	3.281	<0.001*
PCT (%)	0.216 ± 0.05	0.230 ± 0.05	-1.227	0.223

**p< 0.05 is significant*

Key: MCHC = Mean Corpuscular Haemoglobin Concentration, MCH = Mean Corpuscular Haemoglobin, MCV= Mean Corpuscular Volume, RDW-CV = Red Cell Distribution Width- coefficient of variation, RDW-SD = Red Cell Distribution Width-Standard Deviation, PLT = Platelet Count, MPV = Mean Platelet Volume, PDW = Platelet Distribution Width, PCT = Plateletcrit

Table 5. FBC (mean ± SD) of the Test Subjects Based on Age

Parameter	60-64 n = 55	65-69 n = 25	70-74 n = 15	75-79 n = 6	≥ 80 n = 4	f-value	p-value
WBC (10^9/L)	5.7 ± 1.5	4.9 ± 1.2	5.1 ± 1.4	6.1 ± 1.4	4.6 ± 0.3	2.291	0.065
Lymph (10^9/L)	2.7 ± 0.6	2.4 ± 0.6	2.6 ± 0.6	3.0 ± 0.5	2.1 ± 0.3	2.414	0.054
Neut (10^9/L)	2.4 ± 1.0	2.0 ± 0.8	2.0 ± 0.5	2.3 ± 0.7	2.1 ± 0.2	1.215	0.309
Eosino (10^9/L)	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.2 ± 0.1	0.1 ± 0.0	0.678	0.609
Mono (10^9/L)	0.5 ± 0.3	0.3 ± 0.2	0.6 ± 0.3	0.6 ± 0.1	0.3 ± 0.2	2.677	0.036*
RBC (10^{12}/L)	4.3 ± 0.5	4.2 ± 0.4	4.0 ± 0.2	4.2 ± 0.3	4.0 ± 0.3	1.781	0.139
Hb (g/dl)	13.0 ± 0.9	13.3 ± 1.2	12.3 ± 0.5	13.3 ± 0.8	12.4 ± 0.3	3.508	0.010*
HCT (%)	39.9 ± 2.5	40.8 ± 3.9	37.4 ± 1.7	40.4 ± 2.7	37.5 ± 1.0	4.414	0.003*

**p< 0.05 is significant*

Key: WBC = White Blood Cell, Lymph = Lymphocyte, Neut = Neutrophil, Eosino = Eosinophil, Mono = Monocyte, RBC = Red blood Cell, Hb = Haemoglobin, HCT = Haemotocrit

3.6 Red Cell Indices, Platelet and Platelet Indices (mean ± SD) of the Test Subjects Based on Age

Comparison of the MCHC (g/dl) in different age groups showed statistical difference (p=0.002). MCHC was higher in age group 74-75 than other age groups. MCH (pg) of the subjects in different age groups showed statistical difference (p= 0.009). This was obvious between age group 60-64 and 65-69. Serum values of PLT (10^9/L) in different age groups showed statistical difference (p=<0.001). It was higher in age group 60-64 and 75-79 against 65-69 age groups. And comparison of the serum values of PDW in different age groups showed statistical difference (p=0.001). The significant difference in the PDW showed between age groups 60-64 and 65-69 and ≥ 80. Comparison of the serum values of PCT (%) showed statistical difference (p=<0.001). The PCT values have higher values in age groups 60-64, 70-74 and 75-79 than 65-69 age group.

3.7 FBC (mean ± SD) of the Test Subjects Based on BMI

Comparison of the WBC (10^9/L) in different BMI showed statistical difference (p=<0.001). This shows that the obese have high WBC than the normal weight and overweight. Also, comparison of Lymph (10^9/L) of the subjects in different BMI showed statistical difference (p=0.039). Comparison of Neut (10^9/L) of the subjects in different BMI in Nnewi showed statistical difference (p=<0.001). Comparison of Mono (10^9/L) of the subjects in different BMI showed statistical difference (p=<0.001). In almost all the parameters in the table, the obese have high values than the other groups except in eosinophil and Hb. This showed the influence of BMI on full blood count parameters.

3.8 Red Cell Indices, Platelet and Platelet Indices (mean ± SD) of the Test Subjects Based on BMI

Comparison of the RDW-CV and RDW-SD showed significant differences across different classes of BMI (p= <0.001) and (p= 0.013) respectively. But they were not BMI related. Comparison of PLT (10^9/L) of the subjects in different BMI in Nnewi showed statistical difference (p=<0.001). Normal weight has low PLT than overweight and obese. Comparison of MPV of the subjects in different BMI showed statistical difference (p=0.020). But was not BMI related. Comparison of PDW of the subjects in different BMI showed statistical difference (p=0.045). Comparison of PCT (%) of the subjects in different BMI Metropolis showed statistical difference (p=<0.001). The study showed a trend that underweight has high PDW and PCT than the other BMI groups

4. DISCUSSION

Haematological parameters are used to monitor health status, diagnose diseases and monitor patient's response to treatment [20]. In order to interpret and determine the clinical implication of laboratory results of any individual in state of health or disease we need to have the knowledge of the normal reference range for that locality or population [21]. Therefore, this study was set out to evaluate haematological parameters in apparently healthy elderly persons living in Nnewi Nigeria to establish reference ranges for the elderly on the studied variables and compare them with local reference values. This will add value to the management of elderly population. This study established reference values of WBC, lymphocyte, neutrophil, eosinophil, monocyte, basophil, RBC, Hb, HCT, MCHC, MCH, MCV, RDW-CV RDW-SD, Platelet count, MPV, PDW and Plateletcrit for the elderly in Nnewi.

In this study WBC, eosinophil, basophil counts, Hb and PDW were within the local reference ranges used. Neutrophil, monocyte, HCT, MCH and MCH were lower than the local reference ranges used. And lymphocyte, monocyte, RBC, MCHC, MCH, RDW-CV, RDW-SD MPV and PCT were higher than the local used reference ranges in Nnewi. The low values are in support of previous work by Okpokam and Ndemateh [22] in Calabar who reported low HCT values in elderly. This is consistent with previous findings which stated that haematological parameters vary with location and age, hence the need to establish reference ranges for each laboratory [23,1]. The findings are also, in agreement with previous studies that reported lower Hb and HCT for the elderly and variations within geographical locations and ethnic groups (Fairweather-Trait *et al.,* 2014; Torilla *et al.,* 2008). The slight decline in Hb and HCT among the elderly was not because of pathological issues but could be as are a result of inevitable consequences of ageing [1]. In addition to that is poor nutrition resulting in vitamin B_{12} and folic acid deficiency in old age might be another cause of low Hb and HCT

Table 6. Red cell indices, platelet and platelet indices (mean ± SD) of the test subjects based on age

Parameter	60-64 n = 55	65-69 n = 25	70-74 n = 15	75-79 n = 6	≥ 80 n = 4	f-value	p-value
MCHC (g/dl)	32.5 ± 0.7	32.9 ± 1.2	34.0 ± 2.4	33.0 ± 0.7	33.1 ± 0.1	4.618	0.002*
MCH (pg)	30.2 ± 2.2	31.9 ± 2.0	31.1 ± 1.4	32.3 ± 1.7	31.4 ± 3.1	3.608	0.009*
MCV (fL)	93.1 ± 6.7	97.2 ± 4.9	94.4 ± 4.3	97.7 ± 7.2	94.8 ± 8.9	2.280	0.066
RDW-CV (%)	14.3 ± 1.1	14.3 ± 1.2	14.6 ± 2.2	14.2 ± 0.9	14.3 ±1.2	0.121	0.975
RDW-SD (fL)	50.3 ± 5.2	52.1 ± 3.9	51.2 ± 6.9	52.0 ± 5.6	50.1 ± 1.0	0.613	0.654
PLT (10^9/L)	208.1 ± 40.4	164.8 ± 40.5	199.7 ± 44.6	233.3 ± 12.6	161.5 ± 45.6	7.017	<0.001*
MPV (fL)	17.1 ± 3.1	11.7 ± 1.0	11.9 ± 1.2	11.2 ± 0.7	12.2 ± 0.1	0.640	0.635
PDW	15.8 ± 0.3	16.1 ± 0.3	16.0 ± 0.5	15.9 ± 0.3	16.5 ± 0.1	5.348	0.001*
PCT (%)	0.240 ± 0.1	0.192 ± 0.1	0.235 ± 0.1	0.260 ± 0.1	0.196 ± 0.1	7.274	<0.001*

**p< 0.05 is significant*

Key: MCHC = Mean Corpuscular Haemoglobin Concentration, MCH = Mean Corpuscular Haemoglobin, MCV= Mean Corpuscular Volume, RDW-CV = Red Cell Distribution Width- coefficient of variation, RDW-SD = Red Cell Distribution Width-Standard Deviation, PLT = Platelet Count, MPV = Mean Platelet Volume, PDW = Platelet Distribution Width, PCT = Plateletcrit

Table 7. FBC (mean ± SD) of the test subjects based on BMI

Parameter	Underweight n= 6	Normal weight n= 37	Overweight n= 26	Obesity n= 36	f-value	p-value
WBC (10^9/L)	5.4 ± 1.8	4.8 ± 1.0	5.1 ± 0.9	6.4 ± 1.6	11.139	<0.001*
Lymph (10^9/L)	2.6 ± 0.9	2.4 ± 0.5	2.5 ± 0.6	2.8 ± 0.7	2.897	0.039*
Neut (10^9/L)	2.3 ± 0.7	1.8 ± 0.6	2.0 ± 0.3	2.8 ± 1.0	12.307	<0.001*
Eosino (10^9/L)	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.0	0.1 ± 0.1	1.026	0.384
Mono (10^9/L)	0.4 ± 0.1	0.3 ± 0.1	0.5 ± 0.3	0.6 ± 0.3	7.375	<0.001*
RBC (10^{12}/L)	3.8 ± 0.3	4.2 ± 0.5	4.2 ± 0.3	4.3 ± 0.5	1.386	0.251
Hb (g/dl)	12.2 ± 0.4	13.0 ± 1.1	13.0 ± 0.7	13.0 ± 1.0	1.250	0.296
HCT (%)	37.3 ± 0.8	39.8 ± 3.3	39.8 ±2.5	40.0 ± 3.0	1.532	0.211

**p< 0.05 is significant*

Key: WBC = White Blood Cell, Lymph = Lymphocyte, Neut = Neutrophil, Eosino = Eosinophil, Mono = Monocyte, RBC = Red blood Cell, Hb = Haemoglobin, HCT = Haemotocrit

Table 8. Red cell indices, platelet and platelet indices (mean ± SD) of the test subjects based on BMI

Parameter	Underweight n= 6	Normal weight n= 37	Overweight n= 26	Obesity n= 36	f-value	p-value
MCHC (g/dl)	32.7 ± 1.1	32.8 ± 1.1	33.4 ± 2.0	32.6 ± 0.6	2.199	0.093
MCH (pg)	31.9 ± 1.5	31.2 ± 2.7	30.9 ± 1.6	30.4 ± 1.9	1.210	0.310
MCV (fL)	97.2 ± 5.2	95.3 ± 7.3	94.6 ± 4.5	93.4 ± 6.5	0.932	0.428
RDW-CV (%)	14.0 ± 1.4	14.2 ± 1.3	13.7 ± 0.8	15.0 ± 1.3	6.020	<0.001*
RDW-SD (fL)	51.0 ± 7.1	50.7 ± 5.2	48.7 ± 2.7	52.9 ± 5.5	3.745	0.013*
PLT (10^9/L)	242.0 ± 49.4	176.7 ± 34.9	202.5 ± 33.0	204.1 ± 52.2	5.642	<0.001*
MPV (fL)	11.6 ± 2.0	11.6 ± 1.2	23.4 ± 2.7	11.7 ± 0.9	3.410	0.020*
PDW	16.3 ± 0.1	15.9 ± 0.4	16.0 ± 0.3	16.0 ± 0.4	2.778	0.045*
PCT (%)	0.273 ± 0.0	0.202 ± 0.0	0.240 ± 0.0	0.236 ± 0.1	7.896	<0.001*

**p< 0.05 is significant*

Key: MCHC = Mean Corpuscular Haemoglobin Concentration, MCH = Mean Corpuscular Haemoglobin, MCV= Mean Corpuscular Volume, RDW-CV = Red Cell Distribution Width- coefficient of variation, RDW-SD = Red Cell Distribution Width-Standard Deviation, PLT = Platelet Count, MPV = Mean Platelet Volume, PDW = Platelet Distribution Width, PCT = Plateletcrit

among the elderly in the two study locations. Furthermore, though the values of platelet counts were within the normal range but it was observed to be lower than the values of the Caucasians. This calls for attention during clinical trials and decision making to avert thrombocytopenia induced bleeding.

This study showed that mean values of Eosinophil, Monocyte, Hb, HCT, MCV and PDW were significantly higher in elderly male than female (p= 0.026, 0.034, <0.001, <0.001, 0.039 and <0.001) rspectively. This is in support of previous work which stated that several factors like dietary patterns, attitude, age and gender have effect on haematological parameters [1]. And higher PCV and Hb values in males against that of the female counterpart supports previous studies that reported higher PCV and Hb for males[24]. Such gender differences could be attributed to andogenic hormonal influences on erythropoiesis in males among others [25]. This is because, oestrogens dilate and androgens constrict the renal microvasculature. Dilation of vessels above 300 μm in diameter and vasoconstriction of vessels below 300 μm in diameter increase and decrease the haematocrit in blood in arterioles, capillaries and venules, altering the oxygen delivery per unit red cell mass, and providing a mechanism for varying the red cell mass without compensatory changes in erythropoiesis respectively [26].

There were statistical differences in mean values of Monocyte, Hb, HCT, MCHC, MCH, PLT, PDW and PCT among different age groups in Nnewi (p= 0.036, 0.010, 0.003, 0.002, 0.009, <0.001, <0.001 and <0.001) respectively. The study showed that HCT decreases as the age progresses. This is in agreement with previous studies that reported age related changes in some haematological parameters [20]. One possible explanation for low haemoglobin and HCT levels in the aged is the reduced haematopoietic activity, as determined by a decrease in bone marrow cellularity of up to 50% in individuals beyond the age of 60 years, which occurs along with a significant reduction in peripheral blood counts [27].

There were significant increase in mean values WBC, Lymphocytes, Neutrophils, Monocytes, RDW-CV, RDW-SD, PLT, MPV, PDW and PCT among different groups of BMI in Nnewi (p= <0.001, 0.039, <0.001, <0.001, <0.001, 0.013, <0.001, 0.020, 0.045 and <0.001) respectively. This showed that WBC, lymphocytes and neutrophils were high in overweight than normal weight. Eosinophil increased in overweight and decreases in underweight and normal weight. This is in support previous studies that reported a significant increase in neutrophil and platelet counts in the subjects with BMI > 25 kg/m2 and that BMI has positive correlation with the neutrophil, monocyte counts and MCV [28]. The difference in MPV supports previous study that reported that MPV is affected by obesity [29]. However, it supports previous work that reported correlation between weight loss and reduction in MPV and that apart from positive effect of weight loss on cardiovascular disease risk; it may possess anti-platelet activation properties that can contribute its anti-atherogenic effects in obese patients [30]. Furthermore, increased MPV indicates increased platelet diameter, which can be used as a marker of production rate and platelet activation. During activation, platelets' shapes change from biconcave discs to spherical, and a pronounced pseudopod formation occurs that leads to MPV increase during platelet activation [31]. Therefore, there is need to monitor weight to maintain healthy weight in life.

5. CONCLUSION

The study established reference ranges WBC, lymphocyte, neutrophil, eosinophil, monocyte, basophil, RBC, Hb, HCT, MCHC, MCH, MCV, RDW-CV RDW-SD, Platelet count, MPV, PDW and Plateletcrit for the elderly in Nnewi. The parameters under study vary with the locally used reference ranges. This emphasises on the need for each local diagnostic laboratory to establish its workable reference ranges for the elderly for proper diagnosis, treatment and management of anaemia and its related disorders. There were clear indications that gender, age and BMI have effect FBC parameters. This study showed that HCT and Hb were higher in males than females.

6. RECOMMENDATIONS

1. Diagnostic laboratories should establish reference ranges for elderly to enhance better interpretation of results.
2. BMI and Gender should be put into consideration for proper interpretation of FBC

SUGGESTION FOR FURTHER STUDIES

1. The study should be carried out with larger sample size.

LIMITATIONS OF THE RESEARCH

Apparently healthy elderly persons who might be having some unidentified diseases and refused to divulge them which can affect the parameters under study.

CONSENT

Written informed consent was obtained before recruitment into the study.

ETHICAL APPROVAL

Ethical approvals were obtained from Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, Anambra State with reference numbers: NAUTH/CS/66/VOL.12/192/2019/058.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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