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Haematological profile in COVID-19: Insights from Kano, Nigeria

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Abstract

Coronavirus Disease 2019 (COVID-19) was first diagnosed in Wuhan, China, in December, 2019, and later declared a pandemic with a novel β-Coronavirus, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) as causative agent. However, in resource-poor settings with other overburdened public health issues such as malaria, diarrhoea and typhoid fever, clinical virology laboratories are almost impossible to operationalize. This justifies the need for the use of complete blood count (CBC) analysis to guide clinical case management. This cross-sectional study investigated the haematological parameters of 45 symptomatic SARS-CoV-2 confirmed cases in comparison with 45 age- and gender-matched non-COVID-19 apparently healthy controls in Kano, Nigeria. Complete blood count and differentials were analyzed using Dymind DH-36 automated haematology analyzer. The results obtained were compared using independent sample T-test. The mean age of the participants was 39.5±14.8 years, the minimum was 22 years, and the maximum was 45 years. Males constituted the majority (64.4%). In comparison with the controls, COVID-19 individuals had significantly higher mean values for total white blood cell count (P = 0.001) and neutrophils (P = 0.002) and also lower mean values for basophils (P = 0.001), eosinophils (P = 0.001), lymphocytes (P = 0.001), total red blood cell (P = 0.003), packed cell volume (P = 0.001), and haemoglobin concentration (P = 0.001). In conclusion, haematological parameters are valuable indices, and the results can effectively predict individuals infected with SARS-CoV-2 irrespective of disease severity.

Keywords: Complete blood count, COVID-19, diagnosis, Kano, Nigeria, SARS-CoV-2.

Introduction

The first case of Coronavirus Disease 2019 (COVID-19) was first reported in Wuhan, China, in December, 2019 and the causative agent determined to be a novel β-Coronavirus named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) (Zhu *et al.,* 2020). Moreover, clinical manifestation and severity of COVID-19 vary substantially with most COVID-19 cases being asymptomatic or presenting with mild to moderate symptoms that usually manifest as flu-like illnesses or pneumonia (Wu and McGoogan, 2020).

Blood acts as a pathological reflector of an individual exposed to an infectious agent or any noxious substance/toxicant. This justifies the need for complete blood count (CBC) analysis as a routine investigation providing vital parameters that can help in clinical management, including detection of infection or inflammation and anaemia, pathogenesis, response to treatment and staging of an inflammatory process (Horton *et al.,* 2019). Several

haematological parameters such as total white blood cell (WBC) count, lymphocytes, haemoglobin, platelets, and neutrophils (together with neutrophil-lymphocyte ratio) were described in COVID-19 (Palladino, 2021). These parameters play vital roles in the pathological process of SARS-CoV-2 infection and, therefore can be used to classify and manage patients along with their clinical presentations (Liu *et al.,* 2019).

This cross-sectional study is the first of its kind in Kano, Nigeria. Haematological parameters of SARS-CoV-2 positive individuals were investigated and compared with asymptomatic-apparently healthy group with SARS-CoV-2 negative test results.

Materials and Methods

Ethics

The protocol for this study was reviewed and approved by the Health Research Ethics Committee of the Ministry of Health, Kano State (NHREC/17/03/2018). Written informed consent was obtained from the participants before enrolling into the study.

Description of the study area, study design, participants, period, and sites

The study was carried out in Kano, Kano state, northwestern Nigeria. Kano is located at latitudes 120 3' North and longitude 80 31' East, situated within the semi-arid Sudan Savannah zone of West Africa, about 840 kilometers from the edge of the Sahara Desert, and has an estimated (2022) population of 14,363,776, projected at 2.6% per annum growth from the 2006 census. Kano is 481 meters (1,578 feet) above sea level, with a tropical savanna climate and a landmass of 20,131 km2. It is the second largest industrial and commercial center and one of the most crowded cities in Nigeria. The city is cosmopolitan with a large migrant worker population that was estimated to be increasing at the rate of 30% to 40% per annum. Kano experiences a tropical wet and dry climate exhibiting both annual and seasonal variations. Precipitation levels range from 750mm to 850mm annually, fluctuating between wet and dry years (Umar *et al.,* 2021), with August being the wettest month. Temperature dynamics fluctuate from warm to hot seasons, with the advent of the harmattan prevailing from November to February. The weather is hot for most of the year and peaks in April-May.

A comparative cross-sectional study involving symptomatic COVID-19 individuals and age- and gender-matched asymptomatic group with SARS-CoV-2 negative test results was conducted. The COVID-19 cases were recruited and enrolled from the SARS-CoV-2 testing sites designated by the Kano state COVID-19 task force, from January 12th to December 30th, 2022. Within the same period, the controls were randomly selected from apparently healthy (asymptomatic) people with SARS-CoV-2 negative test results.

Sample size determination and sampling technique

The sample size for the study was calculated based on the formula put forward by Charan and Biswas (2013). A proportion of symptomatic COVID-19 patients reported from Lagos state, Nigeria (Otuonye *et al.,* 2021) was used as P1 (89.6% = 0.9) and the proportion of asymptomatic individuals that tested negative for SARS-CoV-2 in Ibadan, Nigeria (Olayanju et al., 2021) used as P2 (54.9% = 0.55). A minimum sample size of 22 participants was determined for each group and increased to 45 to improve precision. Participants (45 each for SARS-CoV-2 positive individuals and controls) were randomly selected and enrolled until the required sample size was achieved.

Data collection tools and procedure

Data were collected from both COVID-19 individuals and the controls using a pre-designed form based on standard clinical criteria. The main aim and objectives of the study were explained to the care providers at the testing sites and the participants and consents obtained as appropriate. Socio-demographic, clinical data, and other relevant information (co-morbidities) were collected from the relevant groups and documented, and maximum confidentiality ensured.

Laboratory Diagnosis of COVID-19

Initially, rapid antigen test (Ag RDT) was used to screen for SARS-CoV-2 from nasal samples

using PanbioTM COVID-19 Ag RDT (WHO, 2020a) and the results confirmed by one-step real-time RT-PCR (WHO, 2020b).

Haematological indices

About 5mls of venous blood was collected from each participant and analyzed using Dymind DH-36 automated hematology analyzer (Shenzhen Dymind Biotechnology Co. Ltd., Shenzhen, China) for complete blood and differential counts.

Statistical Analysis

Data obtained was checked for errors, outliers and completeness. The IBM Statistical Package for Social Sciences (SPSS) version 25.0 was used for the analysis. Categorical variables were described as frequencies and percentages, mean and standard deviation for continuous variables. Mean comparison was tested by independent T-test and a P-value < 0.05 considered significant.

Results

Demographic and clinical profile of the study participants

The mean age of the participants was 39.5±14.8 years, the minimum age was 22 years and the maximum was 45 years. Most of them (71.1%) were within the age range 21-44 years and males constituted 64.4%.

Analysis of the symptoms reported by the COVID-19 individuals revealed that Cough (71.1%) and fever (71.1%) were the most common, followed by sore throat (53.3%), dizziness (46.7%), headache (42.2%), chest pain (37.8%), and runny nose (35.6%). Other associated symptoms include body pain (26.7%), shortness of breath (24.4%), nausea (20.0%), diarrhoea (17.8%), and vomiting (13.3%). The onset and duration of the symptoms were also described. The majority (55.6%) reported having their symptoms for 7-10 days, followed by 3-6 days (31.1%), then 11-14 days (11.1%), and only 2.2% developed the symptoms over 15-17 days. Participants were also asked to report a history of background medical illnesses, 24.4% had diabetes mellitus and 15.6% were hypertensive (Table 1).

Comparing haematological profile of the COVID-19 individuals and the controls

The haematological indices of the COVID-19 individuals and the controls were categorized based on standard reference values (Table 2) and the parameters summarized and compared using an independent sample T-test (Table 2). The Shapiro-Wilk test was not significant, which indicated that the assumption of normality was not violated. When compared with the control group, the COVID-19 individuals showed significantly higher total WBC (mean diff = 1.55; 95%CI: 237-738; P = 0.001) and neutrophils (mean diff = 849; 95%CI: 137-326; P =0.002) counts. On the other hand, they show significantly lower values for basophils (0.45±0.09 versus 1.96±1.91, mean diff = 1.50; 95%CI: 207-931; P = 0.001); eosinophils (1.25±1.08 versus 1.65±0.31, mean diff = -402; 95%CI: -741 to -064; P = 0.001) ; lymphocytes (2.25±0.5 versus 2.29±1.1, mean diff = 636; 95%CI: 275-997; P = 0.001) ; total red blood cells count (3.97±1.19 versus 4.61±0.65, mean diff = 0.64; 95%CI: 3.62-4.32; P = 0.003); PCV (31.44±4.9 versus 42.43±2.4, mean diff = -10.98; 95%CI: -12.64 to -9.33; P = 0.001) and haemoglobin concentration (10.48±1.7 versus 14.16±0.7, mean diff = -3.68; P = 0.001), respectively (Table 3).

Table 1 Clinical profile of COVID-19 individuals, Kano-Nigeria

Symptom	Frequency (%)	Symptom	Frequency (%)
Fever		**Headache**	
Yes	32(71.1)	Yes	19(42.2)
No	13(28.9)	No	26(57.8)
Sore Throat		**Dizziness**	
Yes	24(53.3)	Yes	21(46.7)
No	21(46.7)	No	24(53.3)
Runny Nose		**Chest Pain**	
Yes	16(35.6)	Yes	17(37.8)
No	29(64.4)	No	28(62.2)
Cough		**Body Pain**	
Yes	32(71.1)	Yes	12(26.7)
No	13(28.9)	No	33(73.3)
Shortness of Breath		**Disease Onset**	
Yes	11(24.4)	3-6 days	14(31.1)
No	34(75.6)	7-10 days	25(55.6)
Vomiting		11-14 days	5(11.1)
Yes	6(13.3)	15-17 days	1(2.2)
No	39(86.7)		
Diarrhoea		**Comorbidity**	
Yes	8(17.8)	Hypertension	7(15.6)
No	37(82.2)	Diabetes Mellitus	11(24.4)
Nausea		None	27(60)
Yes	9(20)		
No	36(80)		

Table 2 Categorization of haematological parameters of the participants

Parameter	Classification	Reference Range	COVID-19 individuals (%)	Control group (%)
White Blood Cells (10^6/L)	Normal	4.0-11.0	30 (66.7)	35 (77.8)
	Low	□ 4.00	4 (8.9)	5 (11.1)
	High	□ 11.0	11 (24.4)	5 (11.1)
Basophils (10^3/L)	Normal	0.10-1.20	31 (68.9)	34 (75.6)
	Low	□ 0.10	11 (24.4)	5 (11.1)
	High	□ 1.20	3 (6.7)	6 (13.3)
Eosinophils (10^3/L)	Normal	0.70-7.00	32 (71.1)	42 (93.3)
	Low	□ 0.70	12 (26.7)	0 (0)
	High	□ 7.00	1 (2.2)	3 (6.7)
Monocytes (10^3/L)	Normal	4.70-12.5	33 (73.3)	35 (77.8)
	Low	□ 4.70	8 (17.8)	9 (20)
	High	□ 12.5	4 (8.9)	1 (2.2)

Neutrophils (10^3/L)	Normal	1.50-7.00	26 (57.7)	31 (68.9)
	Low	□ 1.50	4 (8.9)	2 (4.4)
	High	□ 7.00	15 (33.4)	12 (26.7)
Lymphocytes (10^3/L)	Normal	1.00-3.70	25 (55.6)	35 (77.8)
	Low	□ 1.00	11 (24.4)	4 (8.9)
	High	□ 3.70	9 (20)	6 (13.3)
Red Blood Cells (10^6/L)	Normal	4.30-5.70	17 (37.8)	37 (82.2)
	Low	□ 4.30	28 (62.2)	5 (11.1)
	High	□ 5.70	0 (0)	3 (6.7)
Haemoglobin (g/dL)	Normal	13.7-16.7	17 (37.8)	36 (80.0)
	Low	□ 13.7	28 (62.2)	7 (15.6)
	High	□ 16.7	0 (0)	2 (4.4)
Haematocrit (%)	Normal	40.0-50.0	16 (35.6)	39 (86.7)
	Low	□ 40.0	29 (64.4)	6 (13.3)
	High	□ 50.0	0 (0)	0 (0)
Platelets (10^9/L)	Normal	150-400	36 (80.0)	41 (91.1)
	Low	□ 150	6 (13.3)	3 (6.7)
	High	□400	3 (6.7)	1 (2.2)
NLR	Normal	0.78-3.53	38 (84.4)	40 (88.9)
	Low	□ 0.78	5 (11.1)	2 (4.4)
	High	□ 3.53	2 (4.4)	3 (6.7)

Key: NLR = Neutrophils-lymphocytes ratio.

Table 3 Comparing Haematological parameters of the COVID-19 cases and the controls

Parameters	COVID-19 (n= 45)	Control group (n= 45)	*P*-value	Mean Diff	95%CI	
	Mean±SD	Mean±SD			Lower	Upper
White blood Cells (10^6/L)	7.97±2.3	6.41±1.5	0.001*	1.55	738	237
Basophils (10^3/µL)	0.45±0.09	1.96±1.91	0.001*	1.50	931	207
Eosinophils (10^3/µL)	1.25±1.08	1.65±0.31	0.001*	-402	-741	-064
Monocytes (10^3/µL)	6.19±1.76	7.43±1.38	0.422	-1.24	-191	-578
Neutrophils (10^3/µL)	4.31±1.3	3.46±1.2	0.002*	849	326	137
Lymphocytes (10^3/µL)	2.25±0.5	2.29±1.1	0.001*	636	275	997
Hematocrit (%)	31.44±4.9	42.43±2.4	0.001*	-10.98	-12.64	-9.33
Hemoglobin (g/dL)	10.48±1.7	14.16±0.7	0.001*	-3.68	-4.22	-3.12
Red blood cells (10_6/L)	3.97±1.19	4.61±0.65	0.003*	0.64	3.62	4.32
Platelets (10^9/L)	236.12±104.02	250.71±50.1	0.401	-14.6	-4895	1984
NLR	1.60±0.5	1.61±0.7	0.962	-006	-256	244

Key: **SD** = Standard deviation, **NLR** = Neutrophils-lymphocytes ratio, ***Statistically significant (*P*<0.05), CI = Confidence interval, Diff = Difference.**

Discussion

Coronavirus Disease 2019 (COVID-19) is a great threat to the world population, therefore early monitoring of key indicators is an important basis to guide early assessment of the disease severity, patients triaging and treatment (Li and De Clercq, 2020). The main laboratory changes reported in COVID-19 by most studies include an increase in inflammatory biomarkers, specific tissue injury indicators (liver, kidney, cardiac), and derangement of haematological parameters (Huang et al., 2020). However, there is paucity of data regarding haematological changes associated with COVID-19 in Nigeria. Therefore, this study examined the haematological parameters among 45 COVID-19 patients recruited from different testing sites in Kano State. A matched control (based on age and gender) of 45 apparently healthy individuals with SARS-CoV-2 negative test results were used and the parameters directly compared between the groups and the following findings are reported.

First, this study found the mean age of the study participants to be 39.5±14.8 years with age group 21-44 (71.1%) having the highest proportion of COVID-19 and males were affected the most. This shows that adults were significantly mostly affected by COVID-19 in the study area as opposed to middle-aged reported from Bauchi state, northeastern Nigeria (Jibrin *et al.,* 2020). The finding of this study is comparable with the reports from Nigeria (Amzat *et al.,* 2020), Lagos State, Nigeria (Bowale *et al.,* 2020) and Oman in Middle East (Khamis *et al.,* 2020). In a similar study from Tehran, Iran, the mean age of COVID-19 individuals was 42.7±12.4 years and those in the age range 30-49 years were mostly affected (Mardani *et al.,* 2022). In contrast, a higher mean age of 65 and 66 years were reported in USA (Aggarwal *et al.,* 2020) and Italy (Iaccarino *et al.,* 2020), respectively. These differences could be attributed to variations in geographical location, population pyramid, and genetics.

Reports across different parts of the world indicated higher COVID-19 associated morbidity and mortality in males than females and researchers attributed this to several possible factors such as higher expression of angiotensin-converting enzyme-2 (ACE-2) in males than in females, sex-based immunological differences driven by sex hormone and X chromosome, and gender behavior because males smoke and drink higher than females. While on the other hand, some researchers believed that it is due to the fact that women had more responsible attitude such as frequent hand washing, wearing of face mask and stay-at-home orders towards COVID-19 than men (Bwire, 2020).

Secondly, it was found that the most prevalent symptoms at presentation were; fever, cough, and sore throat, followed by dizziness, headache and chest pain, respectively. This finding is consistent with reports Lagos and Abuja, Nigeria (Bowale *et al.,* 2020; Akerele *et al.,* 2021) and also from the USA, China, Canada, and India (Bwire, 2020; Guan *et al.,* 2020; Singh et al., 2021) although variation may exist with geographical region, climatic condition, duration of symptoms, presence of comorbidity(ies), and disease severity (Yang *et al.,* 2020; Kompaniyets *et al.,* 2021; Onukak *et al.,* 2021; Jackson *et al.,* 2022). Hypertension and diabetes mellitus were the predominant comorbidities identified in this study and agrees with other reports (de Almeida-Pititto *et al.,* 2020; Ejaz et al., 2020; Djaharuddin *et al.,* 2021). Lastly, COVID-19 individuals in this study had significantly lower mean values for lymphocytes, basophils, and eosinophils when compared with the control group. The decrease in lymphocytes could be attributed to direct virus attack and killing of lymphocytes or virus-mediated destruction of lymphatic organs. These findings are comparable with previous reports (Martens *et al.,* 2021; Palladino, 2021; Sun *et al.,* 2020; Tong *et al.,* 2021), however, it contradicts other researchers who reported higher values for lymphocytes, basophils, and eosinophils (Ish *et al.,* 2020; Murdaca *et al.,* 2021; Safarpour *et al.,* 2021; Zein *et al.,* 2022). The present study also showed significantly higher mean total white cells and neutrophils count among COVID-19 group. This could be due to an increase in the number of circulating neutrophils in order to destroy the virus in infected individuals (response to inflammation). However, these findings contradict a report from India (Waris *et al.,* 2021), but quite resembles that from Lagos, Nigeria (Amoo *et al.,* 2022) and also from Italy

(Palladino, 2021). Although not statistically significant, lower mean values were obtained for monocytes, platelets count and NLR in the COVID-19 group. These findings correlate well with other reports (Zheng *et al.,* 2020; Delshad *et al.,* 2021; Buonacera *et al.,* 2022). Other researchers reported higher monocytes count (Nuber-Champier *et al.,* 2022) significant increase in platelets count (Kenya *et al.,* 2022) and NLR (Yang *et al.,* 2020). This disparity could be due to the fact that the COVID-19 patients in this study presented with mild symptoms and were all seen as outpatients. On the other hand, some researchers reported no significant variation in platelets count (Özsari *et al.,* 2021) and NLR (Mediu *et al.,* 2022), respectively.

Similarly, this study observed a significantly lower mean values of total red blood cells, pack cells volume and haemoglobin concentration in the COVID-19 group when compared with the controls. This could be associated with the action of the virus against the development, degradation of RBCs or existence of comorbidities. These findings are comparable to that of Amoo and Co-researchers (2022) who reported a significant decreased in red blood cell count, pack cells volume, and haemoglobin concentration in Lagos, Nigeria. It also agrees with reports from China (Yuan *et al.,* 2020) and Italy (Berzuini *et al.,* 2021). In contrast, some researchers found a significantly higher red blood cell count and haemoglobin concentration among COVID-19 patients in Turkey (Usul *et al.,* 2020) and Saudi Arabia (Kamel *et al.,* 2021), respectively.

In general, the contradiction between results of previous studies and this study may be due to the fact that most previous studies used the haematological parameters to differentiate between severe and non-severe COVID-19 cases while in the current study the participants had mild presentations. Secondly, the population distribution (population pyramid) of Nigeria is a strong factor to account for most of the differences observed. It can be deduced from the literature that countries with higher cases of COVID-19 and associated morbidities and mortalities had large population of elderly, the most vulnerable group. Another important variable to account for the differences is the abundance of sunlight in Africa, which is a major source of vitamin D. Studies have shown that sunlight influences SARS-CoV-2 infection and disease outcomes (Asyary and Veruswati, 2020; Daneshkhah *et al.,* 2020; Jothimani *et al.,* 2020). Thus, strong exposure to sunlight in African countries may also contribute to lower cases of COVID-19 and case fatalities as against countries in other continents.

Conclusion

Complete blood count as a routine laboratory test provides vital parameters in clinical practice and can be used to predict the likely aetiologic agent of a disease. The findings of this study revealed a significantly higher total WBC and neutrophils count and also lower mean values for basophils, eosinophils, lymphocytes, total RBCs count, PCV, and haemoglobin concentration among COVID-19 individuals in Kano, Nigeria, when compared with apparently healthy non-COVID-19 group. It is therefore recommended that complete blood count be carried out as a routine test in all patients with suspected COVID-19. This will serve as a screening and help upload pressure on molecular diagnostic tests.

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