

Original Research Article

Reference Values for Hemoglobin and Red Blood Cells Indices in Sudanese in Khartoum State

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ABSTRACT

Introduction: Any population is diverse from the other and there are multiple factors which can influence normal physiological values for a given set of population making it compulsory to have reference values of the local population before translating any results into any clinical setting.

Objectives: The aim of this study to establish the reference values of Hb and red blood cells indices in healthy Sudanese in Khartoum State.

Methods: This was a cross sectional study conducted during 2017 in Khartoum state. A total of 438 healthy adults between 20 and 60 years resident in the Khartoum state (90 males and 348 females) were included. A complete blood count (CBC) was performed for Hb, RBCs, PCV, MCH, MCV and MCH Cusing Sysmex KX-21 automated haematology analyser.

Results: Hemoglobin (Hb) level ranged from 13.4 to 16.4 g/dl with a mean value of 14.9 g/dl in males, and 10.7 to 13.7 g/dl with a mean value of 12.2 g/dl in females. The mean of MCV in males was 89.8±9.3fl and in females was 86.2±9.8fl, MCH in males was 28.7±2.8pg and in females was 27.3±4pg while MCHC in males and females were 32.2±2.7 g/dl and 31.4±2.5 g/dl respectively. The mean red blood cells (RBC) count in males and females were 5.2±0.5 x10⁶/μL and 4.5±0.4 x10⁶/μL respectively.

Conclusion: Some CBC reference values like Hb level in Khartoum state were lower than the international values. The obtained results are of value in clinical practice and research.

Key words: Hb; blood indices; reference value.

INTRODUCTION

The hemoglobin (Hb) level of normal subjects is greatly variable and is determined by both genetic and environmental factors. Besides age and sex, acquired factors such as diet, smoking, body weight, hypoxia and infections influence the Hb levels. ^(1,2) Evidence was derived from the observation that normal Caucasians have higher Hb levels than black individuals matched for age and sex. ^(3,4) Controversy surrounds the definition of normal Hb

ranges, an issue relevant to the definition of anemia, which is usually based on WHO criteria (Hb <12 g/dl in females and Hb <13.0 g/dl in males). These criteria were established several years ago, based on Caucasian data by different measurement techniques. In a study on Hb level in 1000 Sudanese children more than 50% of them were anemic according the WHO definition although they were healthy without any symptoms of anemia. ⁽⁵⁾

The WHO limits of normal Hb level and the problem of establishing normal Hb levels according to the population studied and the individual age has been questioned. (6,7) The analysis of large databases of normal subjects available in the US led to a proposal of new limits for the definition of anemia in white and black subjects. (8)

In general, every population is diverse from the other and there are multiple factors which can influence normal physiological values for a given set of population making it compulsory to have reference values of the local population before translating any results into any clinical setting. One must not generalize the use of these reference values as one result which can be normal for one group of population, might not be normal for the other living in a totally different area. Furthermore, the effect of race, genetic diversity of populations is well recognized to differ from one area to another. (9) It has, therefore, been stressed that each population must establish its own Hb reference values for use in clinical assessments. (10,11)

Until now, blood cells and red cells indices reference values in Sudan have not been established. The values usually used are those of Caucasian populations. Till now Sudanese physicians and doctors depend on the universal reference values of RBCs and hemoglobin in diagnosis of diseases. Few studies were performed in this field in specific populations not representing all Sudanese.

The aim of this study to establish the reference values of hemoglobin, RBCs and haematological indices in healthy Sudanese in Khartoum State, as part of a big scale project covering all areas of Sudan.

METHOD

A Cross sectional descriptive study was conducted during 2017 in Khartoum state, Sudan. 438 adults were included 90 males and 348 females. Subjects with hematological disorders or chronic diseases like hypertension, diabetes mellitus, liver diseases, renal diseases, cardiac diseases,

TB, asthma, thyroid disorders, or with Recent acute diseases (Malaria, typhoid fever ...etc)were excluded from the study. Also any subject with recent history of surgery especially splenectomy were excluded. All healthy Sudanese people between 20-60 years old and living for at least one year in the Khartoum State were included. Ethical clearance was obtained from the Federal Ministry of Health and National Ribat University and written consent was taken from each participant.

All selected subject's filled questionnaire including information about personal data, clinical history (past and present history of any disease), physical activity, diet and smoking habits.

Age (age was recorded from birthday by calendar), standing height was recorded without shoes on a wall mounted measuring tape and weight was recorded without shoes on weighing scale.

Sample collection: 2-3 ml of venous blood was collected into vacutainer tubes containing K3E-EDTA (Anticoagulant), and blood was analysed using Sysmex KX-21 automated haematology analyser.

RESULTS

The mean age of the 438 participant was 28 years for males and 24.8 years for females, with mean body mass index of 22.3 ± 4.6 and 22.8 ± 4.7 respectively.

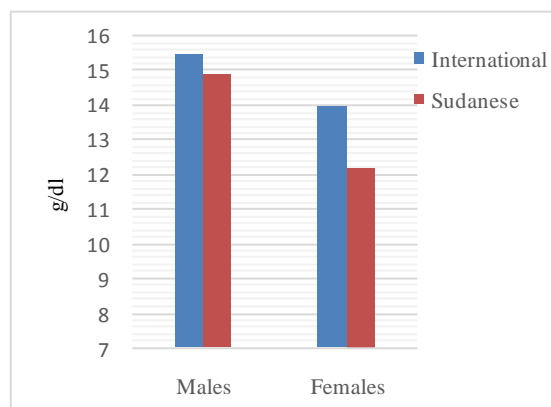


Figure (1): Comparison of adult Sudanese hemoglobin reference values compared with the international values.

The mean Hb values of men and women were 14.9 ± 1.5 gm/dl and 12.2 ± 1.5 gm/dl,

respectively (figure 1) with a range of 13.4-16.4 for males and 10.7-13.7 for females. The mean of RBCs count in males was $5.2 \pm 0.5 \times 10^6/\mu\text{L}$ and in females was $4.5 \pm 0.4 \times 10^6/\mu\text{L}$. Statistically significant ($P < 0.001$) gender differences were seen in Hb, RBCs, PCV and ($P < 0.05$) in MCV, MCH and MCHC (Table 1).

Table (1): Hb and RBCs indices reference values for Sudanese in Khartoum state.

	Male (n=90) Mean±SD	Female (n= 348) Mean ± SD	P-value
Hb (g/dl)	14.9 ±1.5	12.2±1.5	0.000
RBCs($\times 10^6/\mu\text{L}$)	5.2±0.5	4.5±0.4	0.000
PCV (%)	46.4±5.3	39.2±5	0.000
MCV (fl)	89.8±9.3	86.2±9.8	0.002
MCH (pg)	28.7±2.8	27.3±4	0.001
MCHC (g/dl)	32.2±2.7	31.4±2.5	0.005

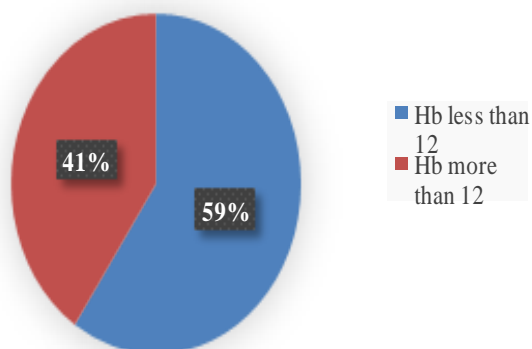


Figure (2): Prevalence of anemia in non-pregnant women in Khartoum state according to the WHO.

The proportion of participants with anemia according to WHO criteria was 9% in male and 41% in females (figure 2)

DISCUSSION

This study aimed at establishing haematological reference values to serve as standards for the interpretation of laboratory results for diagnosis and follow-up in clinical practice and screening in routine healthcare in the Khartoum state.

In this study, the mean Hb values at all age strata were significantly higher ($p < 0.001$) for men than women. Such gender variation is in agreement with the findings of other previous studies from different parts of the world. (12-15) This may be because of the testosterone stimulatory effect to Erythropoiesis in males.

These findings did not differ much from those reported in most of African countries like Nigeria, (16) Botswana, (17) Kenya (18) and Uganda (19) (table 2) except Ethiopia which showed higher Hb level, 16.1 in males and 14.3 in females g/dl (20)

The possible explanation for high hemoglobin level in Ethiopia could be due to effect of hypoxia which increases erythropoietin secretion.

Table (2): Comparison of adult Hb and RBCs indices between Sudanese in Khartoum State and the international values.

	Parameter	Sudanese in Khartoum State	United State (21)
Male	RBCs ($\times 10^6/\mu\text{L}$)	4.7-5.7	4.69-6.07
	Hb(g/dl)	13.4-16.4	14.6-17.8
	PCV (%)	41.1-51.7	40.8-51.9
	MCV(fl)	80.5-99.1	77.8-94.0
	MCH(pg)	25.9-31.5	26.5-32.6
	MCHC (g/dl)	29.5-34.9	32.7-36.9
Female	RBCs ($\times 10^6/\mu\text{L}$)	4.1-4.9	3.88-5.46
	Hb(g/dl)	10.7-13.7	12.1-15.9
	PCV (%)	34.2-44.2	34.3-46.6
	MCV(fl)	76.4-96	77.8-94.0
	MCH(pg)	23.3-31.3	26.5-32.6
	MCHC (g/dl)	28.9-33.9	32.7-36.9

If the normal Hb by WHO is 14g/dl for females and 15.5g/dl for males and anemia according to the WHO is Hb <12 g/dl in females and Hb <13 g/dl in males with a decrease of 15% from the normal WHO value, then anemia in Sudanese if taken as a drop of 15% from normal it should be Hb < 10.4 g/dl in females and <12.7 g/dl in males by subtracting the percentage drop from the Sudanese normal.

Table (3) Comparison of adult Hb and RBCs indices reference values obtain from this study with some African countries and USA.

	Parameter	Nigeria n=124	Botswana n= 126	Kenya n=1020	Uganda n= 520	Sudanese (this study)	US
Male	RBCs(x10 ⁶ /μL)	5.1-5.3	4.4-6.0	4.4-6.3	3.8-6.1	4.7-5.7	4.69-6.07
	Hb(g/dl)	14-14.4	13-17	8.3-11.3	11.6-17.1	13.4-16.4	14.6-17.8
	PCV (%)	43.5-45	38-49	40-50	33.8-49.5	41.1-51.7	40.8-51.9
	MCV(fl)	84.3-86.6	76-93	71.4-98.2	71-97	80.5-99.1	77.8-94.0
	MCH(pg)	27.2-28.1	24-33	23.3-33.8	23-33.8	25.9-31.5	26.5-32.6
	MCHC (g/dl)	31.9-32.4	31-37	32.2-35.2	32.4-35.3	29.5-34.9	32.7-36.9
Female		n= 125	n= 135	n=521	n= 141		
	RBCs (x10 ⁶ /μL)	4.5-5.3	3.7-5.1	3.7-5.6	3.3-5.3	4.1-4.9	3.88-5.46
	Hb(g/dl)	12.4-13.1	9-15	5.9-10	9.8-16.2	10.7-13.7	12.1-15.9
	PCV (%)	38.8-40.5	29-43	30-50	28.3-46.8	34.2-44.2	34.3-46.6
	MCV(fl)	84.8-86.5	65-95	66-95.7	74-94.5	76.4-96	77.8-94.0
	MCH(pg)	27.1-28.9	20-32	21.3-33	24.8-32.7	23.3-31.3	26.5-32.6
	MCHC (g/dl)	31.8-32.3	31-37	32.2-35.3	33-35.5	28.9-33.9	32.7-36.9

CONCLUSION

In conclusion, the normal Sudanese Hb reference values are lower than the international ones and this will change the Hb level for anaemia diagnosis in Sudan.

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