Original Research Article

Normal range of white blood cells and differential count of Sudanese in Khartoum state

Elmutaz H. Taha¹*, Mohammed Elshiekh¹, Abdelrahim Alborai², Elnagi Y. Hajo³, Abdelmohisen Hussein⁴, Kamal M. Awad⁴, Ibrahim A. Ali⁵, Omer A. Musa⁵

¹Department of Physiology, Faculty of Medicine, Dongola University, Sudan
²Department of Physiology, Faculty of Medicine, Omdurman Islamic University, Sudan
³Department of Physiology, Faculty of Medicine, The National University, Sudan
⁴Department of Physiology, Faculty of Medicine, Gadarif University, Sudan
⁵Department of Physiology, Faculty of Medicine, National Ribat University, Sudan

Received: 21 May 2018
Accepted: 28 June 2018

*Correspondence:
Dr. Elmutaz H. Taha,
E-mail: elmutaz.taha735@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The normal physiological range for white blood cells and differential count are essential for diagnosis, treatment, follow up and screening. This study aimed at establishing the reference ranges of WBCs and differential count in Sudanese people.

Methods: The present study included 444 healthy adult Sudanese from both sexes with age range of 20 – 60 years. Blood samples were obtained from brachial veins and drawn in EDTA tubes. WBCs and differential count were analyzed using Sysmex KX-21 automated hematology analyzer. Full clinical examination was performed, weight and height were measured, and BMI was calculated.

Results: The mean WBC count was 5.1±1.5×10³/µl with a range of 3.6×10³/µl to 6.6×10³/µl. The mean WBCs count for males and females were 4.969×10³/µl and 5.138×10³/µl respectively. Neutrophils count was 2.430×10³/µl (47%) and mean for lymphocyte count was 2.116×10³/µl (41.1%).

Conclusions: WBCs count was directly proportional to BMI. The WBCs count of Sudanese people was lower than that of Caucasians and similar to reports from other African countries.

Keywords: BMI, Differential count, WBCs

INTRODUCTION

Appropriate local reference values for hematological parameters are important for diagnosis, treatment, follow up and screening. The reference values of hematological markers currently used in Asia and Africa have been obtained from researches on populations in developing countries and may not be applicable in most regional settings.¹ The lack of appropriate hematological reference range may cause unnecessary follow up investigations, treatment and mismanagement of patients.² In addition, many different factors such as age, gender, ethnicity, geographical and environmental factors have an impact on the hematological parameters in different population.³

Recently studies conducted in Asian and African countries demonstrated lower hematological parameters compared with those from populations in industrial countries.⁴,⁵

Recent studies demonstrated significant differences in the hematological reference ranges by sex and between studied groups. They also showed that there were
considerable differences in the reference values from western population compared with those from the local population. White blood cells (WBCs) count in obese subjects were found significantly higher than in non-obese subjects. A study done by A.A Abbas and others in Gezira State revealed that there was no significant difference in WBCs count between Sudanese people and international reference values. In another study conducted in Khartoum state reported that WBCs count showed the same result when compared with international reference values. In contrast to these results, WBCs count and differential count showed significant variation in Sudanese young adults healthy males in comparison with the reference ranges of African and American. It is necessary to conduct a study involving a large sample size for more accurate determination of WBCs and differential count in Sudanese. Therefore, we have conducted this study to establish the reference ranges of WBCs and differential counts in Sudanese people and to correlate them with age, sex and BMI.

METHODS

This was a cross sectional descriptive study approved ethically by Sudan Federal Ministry of Health and the National Ribat University. This initial study was conducted in Khartoum state from December 2016 to April 2017. The participants were healthy Sudanese males and females between 20-60 years old and residence for at least one year in Khartoum. Participant with Chronic diseases (Hypertension, diabetes mellitus, liver diseases, renal diseases, cardiac diseases, TB, asthma, thyroid disorders), hematological disorders, recent acute diseases (malaria, typhoid fever) surgery, pregnancy and lactation, splenectomy and history of schistosomiasis were excluded.

Each of the participants provided a written informal consent after fully explaining to them the project. A questionnaire was filled by each participant individually. Blood sample was drawn from the brachial vein by the standard procedure with a Vacutainer into tubes containing K3E-EDTA (Anticoagulant) and gently mixed by inverting the tube five to six times immediately after drawing. WBCs and differential count were measured using Sysmex KX-21 automated hematology analyzer. Weight and height were measured with standard techniques. BMI was calculated as weight (kg)/height (m)². Complete clinical examination was performed. Data was collected in data collection sheet excel. Results obtained were analyzed by Statistical Package for the Social Sciences (SPSS) software version 23 (SPSS Inc., Chicago, IL). The mean and standard deviation were calculated for each parameter. Student test was used for normally distributed data and to compare between two groups. One Way ANOVA was used to compare between different groups. P ≤0.05 was considered statistically significant.

RESULTS

A total of 444 healthy adults were included, 353 (79.5 %) were females and 91 (20.5 %) were males, with age range of 20-60 years.

The mean±SD of WBCs count for Sudanese in Khartoum state was 5.1±1.5×10³/µl compared to international value of 7.5±10³/µl, but comparable to African countries (Table 1). The mean differential count±SD is presented in (Table 2).

There is no significant difference between males and females in the WBCs count, 4.969/µl and 5.138/µl respectively, but the count for the age group 30-39 was 5.465±1.22 and for the age group above 50 was 4.843±2.08. There was statistically significant difference between underweight and obese for WBCs count (P ≤0.05). WBCs count was directly proportionate with BMI (Table 3).

Table 1: Comparison of WBCs values of Sudanese with International values from Caucasians.

| Parameter          | Mean for Sudanese | Mean for International |
|--------------------|-------------------|------------------------|
| WBCs count         | 5.103/µl          | 7.500/µl               |
| Male WBCs count    | 4.969/µl          | 7.500/µl               |
| Female WBCs count  | 5.138/µl          | 7.500/µl               |

The mean for the WBCs count was found to be 4.969 x 10³/µl for men, with a higher mean of 5.138 x10³/µl for women. The difference was not significant; but when we compare the mean of WBCs count in Khartoum state (Sudan) to the International values it is found to be significantly low (5.103 x10³/µl and 7.500x10³/µl respectively). The WBCs count in Sudanese is similar as those from African countries, but significant lower than the International values.

Table 2: Mean values of WBCs differential in Sudanese.

| Variables (thousand/ µl) | Mean | Std. deviation | % of Sudanese mean | % of international mean |
|--------------------------|------|----------------|--------------------|------------------------|
| Lymphocyte count         | 2.116| 0.9            | 41.1% (45% male 40% female) | 20-40%                |
| Neutrophils count        | 2.430| 1.5            | 47% (40% male 45% female)  | 45-75%                |
| (monocytes, basophils and eosinophils) count | 0.678| 0.4            | 11.7               | 3-13%                 |
The mean of total WBCs count was 5.103×10^3/μL and the absolute neutrophils counts was 2.43×10^3/μL. The mean lymphocyte counts in males and females were, respectively, 2.1×10^9/L and 2.2×10^9/L.

Neutrophil and lymphocyte counts were also significantly higher in females compared to males.

**Table 3: Comparison WBCs count between BMI categories.**

| BMI classification | N (%) | Mean±SD  |
|--------------------|-------|----------|
| Under weight       | 102   | 4.802±1.504** |
| Acceptable         | 223   | 5.078±1.474   |
| Over weight        | 82    | 5.333±1.493   |
| Obese              | 36    | 5.589±2.034** |

**P ≤0.05 underweight versus obese**

The WBCs count in Sudanese was directly proportion to the BMI.

Underweight subjects had lower WBCs count than obese subjects and the difference was statistically significant P ≤0.05. WBCs count significantly increased by BMI.

**DISCUSSION**

The goal of this study was to establish the reference ranges of WBCs and differential count in Sudanese and correlate them with age, sex and BMI. The WBCs count is globally lower among black people than in Caucasians.6,10,11 In present study we have demonstrated that WBCs count in Sudanese healthy adult was significantly lower than International reference values. In addition, our results are similar to many African countries such as Central Africa, Uganda and Tanzania and lower than South Africa and Ethiopia.12-16 The cause of these differences is unclear, although dietary, environmental and genetic factors have been reported.13,17

Neutrophils count was reported lower in all black African and American population.18,19 Present study revealed that neutrophils count in Sudanese people is similar to black African population. Mechanisms by which black African people have neutropenia is still not explained. Furthermore, lymphocyte count in Sudanese people was similar to those reported from African studies.5,13

In this study a slight insignificant difference of mean WBCs count was observed between males and females in Sudanese people. In consistence with our result previous studies have documented minor differences of mean WBCs count from different parts of the world.5,20-22 In contrast, Rukia and his colleagues demonstrated statistically significant differences in WBCs and differential count by gender in Kenya, where males had lower values than females (Table 1).23 This study demonstrates that mean WBCs count was markedly lower in underweight Sudanese people compared with obese one and directly proportion with BMI (Figure 2). The mean WBCs and differential count was higher in obese compared to non-obese women.24 Shimakawa et al reported that the mean WBCs count is positively associated with components of metabolic syndrome, such as BMI and WHR.25 In obese subjects Adipose tissue produces and releases a variety of inflammatory factors and adipokines as well as cytokines such as IL-6 and IL-8.26 WBCs count was increased by cytokines, especially IL-6.27 IL-6 by itself further increases the production of C Reactive Protein (CRP) in obesity. This elevated amount of CRP is taken up by WBC, promotes migration of WBC into arterial wall.28

**CONCLUSION**

In conclusion, authors demonstrated that the WBCs count of Sudanese people was similar to reports from other African countries and lower than Caucasians. In addition, the WBCs count was directly proportional with BMI.

**ACKNOWLEDGEMENTS**

Authors would like to acknowledge participants for accepting to come in their private time for the study and for the National Ribat University and Central lab of Police hospital for providing fund for this project.

**Funding: National Ribat University and Central Lab of Police Hospital**

Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

**REFERENCES**

1. Haileamlak A, Muluneh AT, Alemseged F, Tessema F, Woldemichael K, Asefa M et al. Hematoimmunological Profile at Gilgel Gibe Field Research Center, Southwest Ethiopia. Ethiopian J Health Sci. 2012;22:39-50.
2. Dosoo DK, Kayan K, Adu-Gyasi D, Kwara E, Ocran J, Osei-Kwakye K et al. Haematological and biochemical reference values for healthy adults in the Middle Belt of Ghana. Szcse PB, ed. PLoS One. 2012;7(4).
3. Bain B, Seed M, Godslan I. Normal values for peripheral blood white cell counts in women of four different ethnic origins. J Clin Pathol. 1984;37(2):188-93.
4. Roshan TM, Rosline H, Ahmed SA, Rapiyah M, Wan Zaidah A, Khatkhat MN. Hematological reference values of healthy Malaysian population. Int J Lab Hematol. 2009;31(5):505-12.
5. Kueviakoe IM, Segbena AY, Jouault H, Vovor A, Imbert M. Hematological reference values for healthy adults in Togo. ISRN Hematol. 2011;2011:736-62.
6. NE Urquhart, KD Capildeo, LA Sargeant, G Wharfe, M Hisada, B Hanchard. White blood cell
counts in healthy Jamaican adults. West Indian Medical J. 2008;57:2147-51.
7. Abbas A, Khalil A, Yasar H, Fadlallah S, Huwaida O. White blood counts in apparently healthy Sudanese Blood Donors in Gezira State (Sudan). 2015.
8. Eltoum FA. Establishment of Normal Reference Values of White Blood Cells and Differential Count among Sudanese Healthy Adult Population in Khartoum State: Sudan University of Science and Technology; 2013.
9. Mohi Eldin A, Hussien M, Badi R, Daffa Alla N. Reference ranges of white blood cells and platelet counts among Sudanese young adult males in Khartoum state. Eur J Bio Med Res. 2017;3(3):9-11.
10. Wakeman L, Al-Ismail S, Benton A, Beddall A, Gibbs A, Hartnell S et al. Robust, routine hematology reference ranges for healthy adults. Int J Lab Hematol. 2007;29:279-83.
11. Hsieh MM, Everhart JE, Byrd-Holt DD, Tisdale JF, Rodgers GP. Prevalence of neutropenia in the US population: age, sex, smoking status, and ethnic differences. Annal Internal Med. 2007 Apr 3;146(7):486-92.
12. Menard D, Mandeng MJ, Tothy MB, Kelembho EK, Gresenguet G, Talarmin A. Immunohematological reference ranges for adults from the Central African Republic. Clin Diagnos Lab Immunol. 2003 May 1;10(3):443-5.
13. Lugada ES, Mermin J, Kaharuza F, Ulvestad E, Were W, Langeland N et al. Population-based hematologic and immunologic reference values for a healthy Ugandan Population. Clin Diagnos Lab Immunol. 2004;11(1):29-34.
14. Saatloff E, Schneider P, Kleinfeldt V, Geis S, Haule D, Maboko L et al. Laboratory reference values for healthy adults from southern Tanzania. Trop Med Int Health. 2008 May;13(5):612-25.
15. Ruiz-Argüelles GJ, Sánchez-Medal L, Loria A, Piedras J, Cordova MS. Red cell indices in normal adults residing at altitudes from sea level to 2670 meters. Am J Hematol. 1980 May;8(3):265-71.
16. Tsegaye A, Messele T, Tilahun T, Hailu E, Sahlu T, Doorly R et al. Immunohematological reference ranges for adult Ethiopians. Clinical Diagn Lab Immunol. 1999 May 1;6(3):410-4.
17. Shaper AG, Lewis P. Genetic neutropenia in people of African origin. Lancet. 1971 Nov 6;298(7732):1021-3.
18. Badenhorst CJ, Fourie J, Steyn K, Jooste PL, Lombard CJ, Bourne L et al. The haematological profile of urban black Africans aged 15-64 years in the Cape Peninsula. East Afr Med J. 1995;72(1):19-24.
19. Sahr F, Hazra PK, Grillo TA. White blood cell count in healthy Sierra Leoneans. West Afr J Med. 1995;14(2):105-7.
20. Bain B. Normal ranges. In: Blood cells: a practical guide, 2nd ed. London: Black well Science Ltd;1995:148-52.
21. Karita E, Ketter N, Price MA, Kayitenkore K, Kaleebu P, Nanvubya A, et al. CLSI derived hematology and biochemistry reference intervals for healthy adults in Eastern and Southern Africa. PloS one. 2009;4(2):e4401.
22. Tsang CW, Lazarus R, Smith W, Mitchell P, Koutts J, Burnett L. Hematological indices in an older population sample: derivation of healthy reference values. Clin Chem. 1998;44:196-101.
23. Kimbaya RS, Bautista CT, Sawe FK, Shaffer DN, Sateren WB, Scott PT et al. Reference ranges for the clinical laboratory derived from a rural population in Kericho, Kenya. PloS One. 2008 Oct 3;3(10):e3327.
24. Farhangi MA, Keshavarz S, Eshraghian M, Ostadrahirin A, Saboor-Yaraghi A. White blood cell count in women: relation to inflammatory biomarkers, haematological profiles, visceral adiposity, and other cardiovascular risk factors. J Health Popul Nutr. 2013 Mar;31(1):58-64.
25. Shimakawa T, Bild DE. Relationship between hemoglobin and cardiovascular risk factors in young adults. J Clin Epidemiol. 1993;46:1257-66.
26. Fantuzzi G. Adipose tissue, adipokines, and inflammation. J Allergy Clin Immunol. 2005;115:911-9.
27. Sim E. Humoral Factors, IRL Press, Oxford; 1993:65-119.
28. Park HS, Park JY, Yu R. Relationship of obesity and visceral adiposity with serum concentrations of CRP, TNF-alpha and IL-6. Diabetes Res Clin Pract. 2005;69:29-35.

---

Cite this article as: Taha EH, Elshiekh M, Alborai A, Hajo EY, Hussein A, Awad KM et al. Normal range of white blood cells and differential count of Sudanese in Khartoum state. Int J Adv Med 2018;5:784-7.