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HEMATOLOGICAL REFERENCE VALUES FOR HEALTHY ADULTS IN EGYPT

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Abstract

Hematological reference values are essential for the interpretation of the Results of laboratory tests and treatment decisions. The full blood count reference intervals in Egypt are generally derived from non-Egyptian subjects. This study aimed to establish hematological reference intervals for healthy adults in Egypt. From January 2018 to January 2020, 5620 volunteers were recruited for this study. A total of 5620 was divided into 1846 (32.8 %) males and 2926 (52.1 %) Females. but 848 (15.1 %) volunteers were excluded because of positive laboratory screening results. Males had a higher median of hemoglobin (14 g/dL versus 12.3 g/dL), median of RBC (4.96×10^6/ µL versus 4.35×10^6/ µL), and hematocrit (41% versus 36.2%) than females. The difference in hemoglobin, RBC, and hematocrit by gender was statistically significantly different ($p < 0.05$). Males had lower median white blood cells (6.7×10^3/ µL versus 6.9×10^3/ µL) and median of Platelets (230×10^3/ µL versus 252.5×10^3/ µL) than Females ($p < 0.05$). in comparison to reference values that are commonly used in Egypt, the hemoglobin levels, RBC, and hematocrit from this study were lower.

Keywords: Hematological reference- Healthy adults, environment.

Introduction:

The Laboratory Reference Range is used for the interpretation of laboratory test Results and the proper management of Patients in clinical and research settings. These are established from a result of a sample of the reference population which was selected based on criteria such as gender, age, ethnicity, and the environment (**Wu et al., 2015).** Hematological reference values are essential for effectively screening blood donors, diagnosing diseases, and assessing overall health. and The use of different methods, instruments, and populations can lead to a significant difference in Hematological parameters, such as Red Blood Cells Hemoglobin, hematocrit, Platelets, and White Blood Cells (**Samaneka et al., 2016)**. The advances in standardizing methods, laboratory techniques, and instruments have minimized the effects of site-to-site differences in many analytical methods. The effect of Population instead is one of the key

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remaining variables which can influence reference values (**Samaneka et al., 2016; Wu et al., 2015).**

The usual reference ranges for hematology in the majority of African nations, including Egypt, are derived from populations in Europe and North America. Nonetheless, the normal African population and those of North America and Europe differ noticeably in the values of hematological variables **(Mugisha et al., 2016)**.

Genetic variation, the higher prevalence of pathogens (such as malaria, HIV, HBV, and HCV) **(Ambayya et al., 2014; Dosoo et al., 2012),** numerous constitutional hemoglobin abnormalities (such as sickle cell disease, thalassemia, and hemoglobin C) (**Ambayya et al., 2014)**, dietary, geographic, attitude, and lifestyle differences **(Dosoo et al., 2012)**.

are just a few of the many factors that have been proposed for those differences. Accurate hematological reference intervals must thus be established immediately for the Egyptian population. The goal of the current study was to determine the hematological parameters' 95% reference interval using Egyptian individuals in good health.

Material and methods:

Healthy males and non-pregnant females ranging between 18 and 55 years of age were screened from different regions of Egypt. In order to verify each participant's condition and medical history, each one had an examination and a questionnaire completed. Additionally, post prescreening, the following criteria were used to remove potentially eligible participants who had positive laboratory screening results:

1- Surgery within 6 months.
2- Blood donation or transfusion within 3 months.
3- Hypertension
4- Pregnancy.
5- Hemoglobin concentration which is less than 10 g/dL.
6- White blood cells less than 3×10^3/ µL or more than 12.5×10^3/ µL.
7- A positive test for malaria.

From January 2018 to January 2020, 5620 volunteers were recruited for this study. A total of 5020 was divided into 1846 (32.8 %) males and 2926 (52.1 %) Females. but 848 (15.1 %) volunteers were excluded because of positive laboratory screening results. Table (1).

Table 1: No of samples

Volunteers	Count
Total	5620
Male	1846
Female	2926
Excluded	848

Sample Collection: All Samples were Collected using standard phlebotomy procedures by a clinician. Blood was collected as follows: 5 ml of venous blood into Plain vacutainer tubes or serum separator tubes to be used for renal function and liver function tests and 3 ml of venous blood into purple EDTA tube and mixed 4-6 times to mix with EDTA anticoagulant to prevent clotting and used for full blood counts. Prepared thick and thin films on clean slides and stained by Giemsa stain for malaria microscopy (thin films only fixed with absolute methanol).

Laboratory Testing: Samples were tested within 6 hours after collection. Good laboratory practices (GLP) and standard operating procedures (SOPs) were followed in the execution of every laboratory inquiry. Screening tests are done to exclude samples with positive results. It included blood urea, serum creatinine, AST, and ALT The biochemical tests were analyzed using mindray BA-88A and Biosystems BTS-350.

Full blood count analyses on Sysmex KXN 21 analyzer, mindray 5300, and Biote HL-3125 plus. the biochemical tests were analyzed using mindray BA-88A and Biosystems BTS-350 semi-automatic analyzer. The following analytes were investigated: hemoglobin, hematocrit, mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), Mean corpuscular hemoglobin concentration (MCHC), erythrocytes Count (RBC), leukocytes count (WBC), Platelets count, relative neutrophils, lymphocytes, monocytes, basophils, and eosinophils.

Quality control: The protocols for sample collection and investigation according to CLSI. Samples were analyzed within 6 hours of collection. Use both internal and external quality control protocols. Calibration of the automated analyzer according to the manufacturer's instructions. Use three levels of controls (High, Medium, and Low). the samples were run only when the controls were within range.

Statistical analysis: Statistical analysis was performed using IBM SPSS software package version 20.0 (Armonk, NY: IBM Corp.). Numbers and percentages were used to characterize the qualitative data. The distribution's normality was confirmed using the Kolmogorov-Smirnov test. Values for the mean, standard deviation, median, and reference were used to characterize quantitative data. At the 5% level, the results' significance was assessed. The Student t-test was employed to compare two groups under study for normally distributed quantitative variables.

Results:

Among the 4772 blood donor volunteers with a range of age from 18 to 55 years and different regions of Egypt (Alexandria, Al Beherah, Luxor, and Marsa Matrouh) were included in this study. 1846 (38.7 %)males and 2926 (61.3 %)Females. The median, mean ± S.D. (Standard deviation), and 95% reference intervals (2.5–97.5th percentiles) for hematological parameters in this study are presented in (Table, 2)

Males had a higher mean of RBC (4.9 × 10^6/ µL) than females (4.4 ×10^6/ µL) with statistically significantly different ($p < 0.001$), higher mean of hemoglobin (14 g/dL) than females (12.3 g/dL) with statistically significantly different ($p < 0.001$), higher mean of hematocrit (41.4%) than females (36.4) with statistically significantly different ($p < 0.001$) and higher mean of MCHC (34.2 g/dL) than in females(33.9 g/dL) with statistically significantly different ($p < 0.001$). but the mean of MCV (83.4 fl) in males, (83.7 fl) in females with ($p = 0.136$), and MCH were 28.4 pg in males and females with($p = 0.469$). MCV and MCH No gender differences were observed ($p > 0.05$).

The mean of total WBC in males (6.8× 10^3/ µL) was lower than in females (7× 10^3/ µL) with a statistically significant difference ($p < 0.001$). on the other hand, the similar mean of platelets in males (239.1× 10^3/ µL) was lower than in females (255.3× 10^3/ µL) with a significantly different ($p < 0.001$).

The differential of WBC shows that males had a higher mean relative lymphocyte (37 %) than females (35.1) with significantly different ($p < 0.001$), the higher mean of relative monocyte (5.5 %) than females (5.0 %) with statistically significantly different ($p < 0.001$) and mean of relative basophile (0.3 %) than in females (0.2 %) with significantly different ($p < 0.001$). on the other hand, the mean of relative neutrophile in males (55.5 %) was lower than in females (57.6 %) with a statistically significant difference ($p < 0.001$), mean of relative Eosinophil is similar in males and females (2.1 %).

Table (2): Comparison of males (♂) and females (♀) based on various parameters

		Males (n=1846)			**Females (n=2926)**				
	Unit	**Mean ± SD.**	**Median**	**Reference values**	**Mean ± SD.**	**Median**	**Reference values**	**T**	**p**
Age	**years**	36.7± 11.1	36.0	18.0 – 55.0	33.5 ± 11.6	32.0	18.0 – 55.0	9.685*	<0.001*
Hemoglobin	**g/dL**	14.0 ± 1.0	14.0	12.40 – 16.30	12.3 ± 0.9	12.30	11.0 – 14.10	58.929*	<0.001*
RBCs	**10^6/ µL**	4.9 ± 0.5	4.95	4.16 – 5.90	4.4 ± 0.4	4.36	3.66 – 5.21	41.041*	<0.001*
HCT	**%**	41.4 ± 4.5	41.0	33.70 – 49.40	36.4 ± 3.3	36.20	30.50 – 43.0	40.702*	<0.001*
MCV	**fL**	83.4 ± 7.7	84.35	66.10 – 96.10	83.7 ± 7.4	84.0	69.10 – 96.20	1.491	0.136
MCH	**Pg**	28.4 ± 2.3	28.70	23.30 – 32.30	28.4 ± 2.5	28.70	21.90 – 32.68	0.725	0.469
MCHC	**g/dL**	34.2 ± 2.3	33.90	30.0 – 38.50	33.9 ± 2.0	33.40	30.92 – 37.80	4.439*	<0.001*
Platelet	**10^3/ µL**	239.1±56.6	230.0	158.0 – 376.0	255.3±62.0	252.50	153.0 – 398.0	9.240*	<0.001*
WBCs	**10^3/ µL**	6.8 ± 1.8	6.70	3.90 – 10.70	7.0 ± 1.9	6.90	3.90 – 11.20	3.960*	<0.001*
Neutrophils	**%**	55.5 ± 11.0	57.0	33.0 – 74.0	57.6 ±10.6	58.0	38.0 – 75.0	6.422*	<0.001*
Lymphocytes	**%**	37.0 ±10.3	36.0	20.0 – 59.0	35.1 ± 10.0	34.0	18.0 – 54.0	6.191*	<0.001*
Monocytes	**%**	5.5 ± 1.4	5.0	3.0 – 8.0	5.0 ± 1.3	5.0	3.0 – 8.0	12.508*	<0.001*
Eosinophils	**µ%**	2.1 ± 1.1	2.0	1.0 – 5.0	2.1 ± 1.0	2.0	0.0 – 4.0	0.001	0.999
Basophils	**%**	0.3 ± 0.4	0.0	0.0 – 1.0	0.2 ± 0.4	0.0	0.0 – 1.0	9.917*	<0.001*

SD: Standard deviation Reference values (2.5 – 97.5)
t: Student t-test
p: p-value for comparing Males and Females
*: Statistically significant at $p \leq 0.05$

Table 3: Comparison of median and 95% reference range between our study and other countries:

		OUR STUDY		Ghana		USA		Brazil
		Median	Reference range	Median	Reference range	Median	Reference range	Reference range
Hemoglobin g/dl	Male Female	14.0 12.3	12.40 – 16.30 11.0 – 14.10	15.2 12.5	10.69-18.7 8.19-16.17	12.30	13.5 – 17.5 12 – 16	13.1 – 16.9 11.5 – 14.6
RBCs 10^6/ µL	Male Female	4.95 4.36	4.16 – 5.90 3.66 – 5.21	5.19 4.38	3.61-6.97 3.08-5.88	4.36	4.5 – 5.9 4.0 – 5.2	4.4 – 5.8 3.9 – 5.1
HCT %	Male Female	41.0 36.20	33.70 – 49.40 30.50 – 43.0	45.20 37.40	31.8-61.83 26.76-50.44	36.20	36 – 46 41 – 53	39.9 – 52.1 35.4 – 45.9
MCV (fL)	Male Female	84.35 84.0	66.10 – 96.10 69.10 – 96.20	87.05 86.8	69.71-103.23 64.44-103.53	84.0	80 – 100	81.5 – 100.2 81.0 – 100.1
MCH (Pg)	Male Female	28.70 28.7	23.30 – 32.30 21.90 – 32.68	29.4 28.7	23.30-34.16 19.54-33.73	28.70	26.0–34.0	26.9 – 32.5 26.3 – 32.3
MCHC (g/dl)	Male Female	33.90 33.40	30.0 – 38.50 30.92 – 37.80	33.7 33.1	29.74-37.16 26.81-37.13	33.40	31.0–37.0	30.6 – 34.6 30.5 – 34.5
Platelet 10^3/ µL	Male Female	230.0 252.5	158.0 – 376.0 153.0 – 398.0	186 214	85.93-348.20 110.95-416.30	252.50	150 – 350	128.4 – 302.2 137.9 – 344.7
WBCs 10^3/ µL	Male Female	6.70 6.90	3.90 – 10.70 3.90 – 11.20	5.47 5.62	3.28-11.23 3.25-10.64	6.90	4.5 – 11.0	2.844 – 9.403 2.908 – 10.047
Neutrophil (%)	Male Female	57.0 58.0	33.0 – 74.0 38.0 – 75.0	39.55 44.75	17.57-67.46 20.93-	58.0	40–70	NA

					74.47			
Lymphocyte (%)	**Male** **Female**	**36.0** **34.0**	**20.0 – 59.0** **18.0 – 54.0**	**45.70** **41.25**	**11.98-66.91** **14.59-62.25**	**34.0**	**22 – 44**	**NA**
Monocyte (%)	**Male** **Female**	**5.0** **5.0**	**3.0 – 8.0** **3.0 – 8.0**	**9.69** **8.80**	**4.30-15.17** **4.55 – 17.18**	**5.0**	**4 – 11**	**NA**
Eiosinophile (%)	**Male** **Female**	**2.0** **2.0**	**1.0 – 5.0** **0.0 – 4.0**	**3.0** **2.4**	**0.21-13.91** **0.33-14.30**	**2.0**	**0 – 8**	**NA**
Basophile (%)	**Male** **Female**	**0.0** **0.0**	**0.0 – 1.0** **0.0 – 1.0**	**0.6** **0.5**	**0.10-1.94** **0.10 – 2.14**	**0.0**	**0 – 3**	**NA**

Discussion:

The hematological reference ranges in this investigation showed significant gender-related variation (Table, 2). When compared to reference ranges in other nations, a similar finding was made. Males had greater reference ranges than females for hemoglobin, HCT, and RBC count (Table 2). This result is in line with the majority of previous African investigations.**((Addai-Mensah et al., 2019; Bimerew et al., 2018; Ayemoba et al, 2019; Rosenfeld et al., 2019; B Kone et al., 2017).** as well as the USA (**Kratz et al.,. 2004)**. These gender differences are due to menstrual blood loss in females and the androgenic hormonal effect in males **(Ayemoba et al., 2019**). mean of MCHC in males higher than in females with a significant difference. However there is no significant difference mean of MCV and MCH this is similar to some studies in Africa **(Addai-Mensah et al., 2019**; **Yalew et al., 2016)**.

In this study, the mean of total WBC in males was lower than in females with a statistically significant difference ($p < 0.001$). which is comparable with the studies done in Ghana, Mali, Nigeria, and the USA, but it is similar to the study in Brazil (**Rosenfeld et al., 2019**). The reference range of platelet count was higher in women than in men, consistent with studies by (**Addai-Mensah et al., 2019; Rosenfeld et al**., **2019; Kibaya et al., 2008).** The variances in the hormone types and concentrations generated in the sexes, as well as the impact of erythropoietin release in response to normal menstruation and cross-stimulating megakaryopoiesis, may be responsible for these changes in reference range**. (Addai-Mensah et al., 2019**).

The differential of WBC shows that males had a higher mean of relative lymphocyte, relative monocyte, and relative basophile than females with significant differences the differences were partly confirmed with the mean, but without any differences in the limits. on the other hand, the mean of relative neutrophils in males is lower than in females with a statistically significant difference, there is no significant difference in the mean of relative Eosinophils by gender.

Conclusion: This study established the first hematological Reference values for a larger population in Egypt, This study found that the

Haematological reference values established from a healthy adult of Egypt were different from other African countries, and the international reference values

Recommendation: It is advised that further research be done on hematological reference values across all age groups to establish a standard hematological reference.

References

Addai-Mensah, O., Gyamfi, D., Duneeh, R. V., Danquah, K. O., Annani-Akollor, M. E., Boateng, L., ... & Ofosu, D. N. (2019). Determination of hematological reference ranges in healthy adults in three regions in Ghana. BioMed Research International, 2019.

Ambayya A, Ting Su A, Haryani Osman N, Nik-Samsudin N, Khalid Kh, Meng Chang K, Sathar J, Suriar Rajasuriar J, Yegappan S. (2014). Haematological Reference Intervals in a Multiethnic Population. PLOS one;9(3):e91968.

Ayemoba O, Hussain N, Umar T, Ajemba- Life A, Kene T, Edom U, et al. (2019), Establishment of reference values for selected haematological parameters in young adult Nigerians. PLoS ONE, 14 (4): e0213925**.**

Bimerew, L. G., Demie, T., Eskinder, K., Getachew, A., Bekele, S., Cheneke, W., ... & Mekonnen, Z. (2018). Reference intervals for hematology test parameters from apparently healthy individuals in southwest Ethiopia. SAGE open medicine, 6, 2050312118807626.

K. Dosoo D, Kayan K, Adu-Gyasi D, Kwara E, Ocran J, Osei-Kwakye K, Mahama E, Amenga-Etego S, Bilson P, P. Asante K, A. Koram K, Owusu-Agyei S.(2012). Haematological and Biochemical Reference Values for Healthy Adults in The Middle Belt in Ghana. PLOS one ;7(4):e36308

Kone B, Maiga M, Baya B, Sarro YDS, Coulibaly N, Kone A, Diarra B, Sanogo M, Togo ACG, Goita D, Dembele M, Polis MA, Warfield J, Belson M, Dao S, Orsega S, Murphy RL, Diallo S, and Siddiqu S, 2017, Establishing Reference Ranges of Hematological Parameters from Malian Healthy Adults, J Blood Lymph. 2017 ; 7(1): doi:10.4172/2165783 1.1000154.

Kratz A, Ferraro M, Sluss PM, Lewandrowski KB.(2004), Laboratory reference values. N Engl J Med.;351:1548–1563

O.Mugisha J, Seeley J, Kuper H. (2016). Population based hematology reference ranges for old people in rural South-West Uganda. BMC Res Notes; 9:433

P. Samaneka W, Mandozana G, Tinago W, Nhando N, M. Mgodi N, F. Bwakura-Dangarembizi M, W. Munjoma M, A. R. Gomo Z, M. Chirenje Z, G. Hakim J. (2016). Adult Hematology and Clinical Chemistry Laboratory Reference Range in a Zimbabwean Population. PLOS one ;11(11):e0165821

Rosenfeld, L. G., Malta, D. C., Szwarcwald, C. L., Bacal, N. S., Cuder, M. A. M., Pereira, C. A., ... & Silva, J. B. D. (2019). Reference values for blood count laboratory tests in the Brazilian adult population, National Health Survey. Revista Brasileira de Epidemiologia, 22.

S. Kibaya, C. T. Bautista, F. K. Sawe, et al., (2008), Reference ranges for the clinical laboratory derived from a rural population in Kericho, Kenya, PLoS ONE, vol. 3, no. 10, Article ID e3327, 2008.

Wu X, Zhao M, Pan B, Zhang J, Peng M, Wang L, Hao X, Huang X, Mu R, Guo W, Qiao R, Chen W, Jiang H, Ma Y, Shang H.(2015). Complete Blood Count Reference Intervals for Healthy Han Chinese Adults. PLOS one; 10(3):1371

Yalew, A., Terefe, B., Alem, M., & Enawgaw, B. (2016). Hematological reference intervals determination in adults at Gondar University Hospital, Northwest Ethiopia. *BMC research notes*, *9*(1), 1-9.