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Research Article

Population Based Reference Intervals for Common Blood Haematological Parameters in Healthy Adult living in Jodhpur City, Rajasthan

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Abstract: We examined the reference intervals of various haematological parameters in healthy adult living in Jodhpur, Rajasthan and to compare these values with those obtained for other population in both India and tropical countries. This study was under taken in healthy adults living in Jodhpur, Rajasthan. A total 1000 healthy volunteers whose ages ranged between 20–50 years, were investigated. All laboratory analysis was conducted under standardized conditions at L.N. Memorial Hospital & Research Centre, Jodhpur. In Western Rajasthan male, the haemoglobin concentration in an overall manner ranged from 12.5 to 17.0 g/dl, RBC count ranged from 4.0 to 6.5 x 10^6/µL, white blood cell (WBC) count ranged from 4.0 to 10.4 x 10^3/µL, platelets count ranged from 150 to 381 x 10^3/µL and packed cell volume ranged from 40 to 50%. Likewise M.C.V. ranged from 77.0 to 99.0 fL, M.C.H. ranged from 26.0 to 32.0 pg and M.C.H.C. ranged from 31.0 to 35.0 g/dl. In Western Rajasthan female, the haemoglobin concentration in an overall manner ranged from 11.5 to 16.0 g/dl, RBC count ranged from 3.7 to 6.0 x 10^6/µL, white blood cell (WBC) count ranged from 4.0 to 11.0 x 10^3/µL, platelets count ranged from 150 to 396 x 10^3/µL and packed cell volume ranged from 37 to 50%. Likewise M.C.V. ranged from 77.0 to 98.0 fL, M.C.H. ranged from 26.0 to 32.0 pg and M.C.H.C. ranged from 31.0 to 35.0 g/dl. Our values differed from the existing haematological reference values, thus showing the importance of developing region-specific reference intervals. Our data also showed the importance of establishing gender specific reference intervals.
Keywords: Reference Intervals, Haematological Parameters.

INTRODUCTION

Reference values (or normal values) for haematological parameters used to aid physicians to interpret results of clinical measurements. They may also be used in clinical trials as a guide to setting inclusion/exclusion criteria as well as the basis of safety monitoring for trial participants.

The haematological parameters are influenced by various factors like age, ethnicity, diet, genetic and gender differences. Thus, it is important to define the specific reference values with regards to the age, gender and the region [1-4]. There is increasing evidence that these are clinically valuable bio markers. But less studies have estimated the reference intervals for these parameters in our population [5].

There is ample evidence that clinicians and medical researchers should use method-specific reference ranges in their laboratories which account for gender differences and variances in the ethnic composition of the local society [6]. In particular, reference ranges of haematological indices based on results from western individuals are not in agreement with those calculated from African populations [7].

We now analysed data on haematological parameters in order to assess the distribution of the measurements in our study population.

Moreover, the reference values which have been established by the studies in different geographic locations may not reflect the normalcy of the population in question. Thus, it is always desirable to identify the region specific reference intervals [5].

MATERIAL AND METHODS

We carried out a retrospective study; the reference population comprised of healthy adults. This study was under taken in healthy adults living in Jodhpur, Rajasthan. A total 1000 healthy volunteers (500 males and 500 females) whose ages ranged between 20–50 years, were investigated. All laboratory analysis was conducted under standardized conditions at L.N. Memorial Hospital & Research Centre, Jodhpur.

Inclusion criteria

- Age between 20–50 years.
- Both the genders (Males and Females)

Exclusion criteria

- Pathophysiological states - renal failure, cardiac diseases, chronic respiratory diseases, liver diseases, malabsorption syndromes, malignancies and haematological disorders which included anaemias.
- Systemic diseases – Hypertension and Diabetes mellitus.
- The chronic intake of pharmacologically active agents like alcohol, tobacco or oral contraceptives,
- Replacement or supplementation therapy e.g. Thyroxine, Insulin
- Modified physiological states - pregnancy, psychological and mental disorders-exercise/physical training /food intake prior to blood collection.

Sample collection

All samples were collected between 9.00 am and 11 am. 2.5 ml of whole blood was collected from the cubital vein with a vacutainer system into EDTA tubes.

Tests

A complete haemogram was done by using a NIHON KOHDEN haematology analyzer within four hours of the blood collection. Dedicated reagents and standard methodologies were used. The 2-level quality controls were run every day and the analyzer was maintained according to the manufacturer's instructions during the entire period of the study.

Statistical analysis

Data was recorded in the Excel software and analyzed with Graph-pad Instat-3 software. The mean and standard deviation values were calculated for each parameter. Student's "t" test for two groups was used to compare parameters according to gender. The level of statistical significance were, when $p < 0.05$.

RESULTS

Table 1: Show study Reference intervals, Existing Reference intervals for Western Rajasthan males and females. Hb, RBC Count, PCV, MCV and MCH were significantly raised in male population than Western Rajasthan females ($p<0.01$). Three parameters that is WBC count, Platelet counts and Mean Corpuscular Haemoglobin Concentration were found raised significantly in Western Rajasthan females on compared to Western Rajasthan males ($p<0.05$).

Table 1: Study Reference intervals, Existing Reference intervals in Western Rajasthan

Haematological Parameters	Sex	N	Study Reference interval	Existing Reference interval
Hb (g/dl)	Males	500	12.5-17.0	13.0-17.0
	Females	500	11.5-16.0	12.0-15.0
RBC Count (10^6/µL)	Males	500	4.0-6.5	4.5-5.5
	Females	500	3.7-6.0	3.8-4.8
WBC Count (10^3/µL)	Males	500	4.0-10.4	4.0-10.0
	Females	500	4.0-11.0	
Platelets (10^3/µL)	Males	500	150-381	150-400
	Females	500	150-396	
HCT/PCV (%)	Males	500	40-50	40-50
	Females	500	37-50	38-46
MCV (fL)	Males	500	77.0-99.0	83-100
	Females	500	77.0-98.0	
MCH (pg)	Males	500	26.0-32.0	27-32
	Females	500	26.0-32.0	
MCHC (g/dl)	Males	500	31.0-35.0	32-34.5
	Females	500	31.0-35.0	

RBC = erythrocyte count, Hb = hemoglobin concentration, Hct = hematocrit, MCV = mean corpuscular volume, MCH = mean cellular hemoglobin, MCHC = mean cellular hemoglobin concentration, PLT = thrombocyte/platelet count, WBC = leukocyte count

Table 2: Show means ± standard deviation and the study reference interval (2.5 – 97.5 percentile) for the males and the females.

Table 3: Show present study (Western Rajasthan) compare with India, Pakistan and USA Population.

A total 1000 healthy volunteers whose ages ranged between 20–50 years, were investigated. Our study reference intervals were compared with the existing reference values (Table 1). The Mean, Standard Deviation and study reference interval (2.5 – 97.5 percentile) for males and females are presented in (Table 2).

The males had a higher mean RBC count (4.9 x 10^6/µL versus 4.5 x 10^6/µL), haemoglobin (14.03 g/dL versus 12.50 g/dL), haematocrit (44% versus 40%), MCV (88.12 fL versus 86.32 fL), MCH (28.34 pg versus 27.94 pg), , whereas the females had a higher mean MCHC (32.09% versus 32.00%), WBC count (7.95 x 10^3/µL versus 7.76 x 10^3/µL), , Platelet count (278 x 10^3/µL versus 211 x 10^3/µL), than their counterparts.

Statistically significant gender based differences in the means were observed for all the haematological parameters. These values are currently in use in our laboratory and they were derived, based on the literature and the standard reference books [16-19].

Table 2: Reference Intervals, Means and Standard deviation of the Reference Population (Males and Females) in Western Rajasthan

Haematological Parameters	Males (N = 500)		Females (N = 500)		*p*-value
	2.5 percentile-97.5 percentile reference interval	Mean ± S.D.	2.5 percentile-97.5 percentile reference interval	Mean ± S.D.	
Hb g/dl	13.4-16.1	14.03 ± 0.93	12.1-14.4	12.50 ± 0.72	<0.0001**
RBC Count x 10^6/µL	4.7-5.8	4.9 ± 0.38	4.2-5.5	4.5 ± 0.35	<0.0001**
WBC Count x 10^3/µL	6.4-9.8	7.76 ± 1.37	6.7-10.5	7.95 ± 1.56	0.0479*
Platelets x 10^3/µL	187-281	211 ± 33.98	257-358	278 ± 35.88	<0.0001**
HCT (PCV) %	42-50	44 ± 2.60	38-45	40 ± 2.17	<0.0001**
MCV fL	82.33-97.44	88.12 ± 3.96	84.10-94.59	86.32 ± 3.45	<0.0001**
MCH pg	27.4-31.3	28.34 ± 1.33	27.00-30.29	27.94 ± 1.12	<0.0001**
MCHC g/dl	31.5-33.3	32.00 ± 0.62	31.32-33.5	32.09 ± 0.79	0.0453*

Table 3: Comparison of the Distribution of Values for Haematological Parameters Retrieved from Distinct Populations in Western Rajasthan (Present Study), India, Pakistan, USA

Region	Sex	RBC (10^6/µL)	Hb (g/dL)	HCT (%)	MCV (fL)	MCH (Pg)	MCHC (g/dL)	PLT (10^3/µL)	WBC (10^3/µL)
Western Rajasthan (20-50 years) n = 1000	M	4.9	14.03	44	88.12	28.34	32.00	211	7.76
	F	4.5	12.50	40	86.32	27.94	32.09	278	7.95
India (20-60 years) n = 10,665	M	5.0	14.69	43	87.50	29.50	33.50	248	6.75
	F	4.4	12.17	37	84.00	27.50	32.50	257	6.92
Pakistan (20-45 years) n = 302	M	5.4	13.04	39	76.30	25.54	32.27	255	8.25
	F	4.8	11.63	35	73.84	24.42	37.72	279	8.42
USA (31-40 years) n = 940	M	4.9	15.00	45	92.00	31.00	33.40	NA	6.50
	F	4.3	13.30	40	91.00	31.00	33.30	NA	6.70

M = male, F = female, RBC = erythrocyte count, Hb = hemoglobin concentration, Hct = hematocrit, MCV = mean corpuscular volume, MCH = mean cellular hemoglobin, MCHC = mean cellular hemoglobin concentration, PLT = thrombocyte/platelet count, WBC = leukocyte count, NA = not available

DISCUSSION

We observed a high exclusion rate of about 80% while we conducted the study, based on the inclusion and the exclusion criteria. This was because of the high prevalence of clinical anaemia and Diabetes mellitus in our local population. Statistically significant gender based differences were found for the following parameters and hence, separate reference intervals for the two genders should be considered: Haemoglobin (Hb) concentration, Haematocrit (HCT) ratio, Red Blood Cell (RBC) count, Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), Platelet count and White Blood Cells (WBC) count.

The gender differences seen in haematologic indices is a well establish fact and has been similarly reported in other studies, men having a higher haemoglobin and haematocrit level compared to women [8-11]. Based on the results from this study, the haemoglobin level for a healthy male adult living in Jodhpur should be between 12.5-17.0 g/dl and that for a female, 11.5-16.0 g/dl.

Females had a higher platelet count compared to men, comparable to a study which looked at ethnic and sex differences in WBC and platelet counts [12].

We observed that when our reference intervals were compared with the existing reference ranges which are primarily derived from the western literature, there was a decrease in our study reference intervals for all the red cell parameters in both the genders. This was in agreement with the observations which were made by other Indian authors [13, 14].

The platelet count values did not show much difference from the existing reference values (5-6% outliers). This observation was in contrast to those of the previous studies from our region [15], who had reported a lower upper limit of the platelet count.

This difference could be due to environmental or genetic factors or a combination of both or to several other factors. Such differences indicate the need to develop reference values that are appropriate for the applicable population.

CONCLUSION

Gender specific reference intervals are essential as there were statistically significant gender related differences in the RBC parameters, the platelet parameters. The reference intervals which were established by our study differed from the existing reference values.

Though it is practically difficult to include age specific reference intervals in our haematology report for all the cases, it is always useful while studies are conducted where such parameters are used.

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