

## ORIGINAL ARTICLE

# Determination of Complete Blood Count Reference Intervals by an Indirect Method for Newborns, Adults, and Geriatric Ages

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### SUMMARY

**Background:** The availability of a reliable reference interval is crucial for clinical decision-making. Correctly defined reference intervals for different age groups are currently unavailable for many parameters. Our study aimed to determine the complete blood count reference intervals in our region from newborn to geriatric ages with an indirect method.

**Methods:** The study was carried out at Marmara University Pendik E&R Hospital Biochemistry Laboratory between January 2018 and May 2019 using the laboratory information system data. The complete blood count (CBC) measurements were performed by Unicel DxH 800 Coulter Cellular Analysis System (Beckman Coulter, FL, USA). A total of 14,014,912 test results belonging to infants, children, adolescents, adults, and geriatric ages were collected. We analyzed 22 CBC parameters, and an indirect method was used for reference interval determination. Data were analyzed according to the Clinical and Laboratory Standards Institute (CLSI) C28-A3 guideline for defining, establishing, and verifying reference intervals in the clinical laboratory.

**Results:** We have established reference intervals from newborn to geriatric ages for 22 hematology parameters [hemoglobin (Hb), hematocrit (Hct), red blood cell (RBC), mean red cell volume (MCV), mean red cell hemoglobin (MCH), mean red cell hemoglobin concentration (MCHC), red cell distribution width (RDW), white blood cell (WBC) count, WBC differentials, including percentages and absolute counts, platelet count, platelet distribution width (PDW), mean platelet volume (MPV) and plateletcrit (PCT)].

**Conclusions:** Our study showed that reference intervals established with data obtained from clinical laboratory databases are comparable to those created using direct methods.

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## Supplementary Data

Table S1. Age and gender-specific reference intervals for hematology analytes.

		0 days F	0 days M	1 - 3 days F	1 - 3 days M	4 - 7 days	8 - 15 days	16 - 31 days	1 - 2 month	2 - 6 month F	2 - 6 month M
Monocytes (%)	n	388	404	587	560	299	249	214	471	826	621
	Lower limit	3.5	3.9	4.4	4.7	7.8	6.6	6.5	5.8	4.6	4.4
	Upper limit	11.9	13.0	13.7	14.4	21.4	21.2	20.0	18.0	15.1	14.6
Monocytes (x 10 <sup>9</sup> /L)	n	402	418	605	584	150	96	194	425	647	871
	Upper limit	2.7	2.5	2.6	2.3	2.4	2.2	2.2	1.7	1.6	1.8
Eosinophils (%)	n	352	372	681	503	217	207	124	418	755	570
	Lower limit	0.3	0.4	0.3	0.4	1.3	1.3	1.8	0.8	0.3	0.2
	Upper limit	3.7	5.9	9.4	9.2	10.9	9.1	13.0	10.5	8.9	8.7
Eosinophils (x 10 <sup>9</sup> /L)	n	393	406	605	577	147	206	195	415	623	784
	Upper limit	0.6	0.8	0.9	1.1	1.1	1.0	1.1	0.8	0.7	0.8
Basophils (%)	n	381	397	580	548	153	144	286	424	655	845
	Upper limit	1.63	1.51	1.91	1.63	2.57	2.14	1.39	1.48	1.15	1.10
Basophils (x 10 <sup>9</sup> /μL)	n	371	392	550	555	150	98	187	435	663	860
	Upper limit	0.3	0.3	0.35	0.34	0.1	0.2	0.2	0.2	0.1	0.1
Mean corpuscular volume (fL)	n	351	372	534	612	134	92	170	415	644	855
	Lower limit	96	95	96	96	94	90	89	80	70	67
	Upper limit	112	113	112	111	114	107	106	98	88	89
Mean corpuscular hemoglobin (pg)	n	383	406	634	642	147	279	340	498	702	944
	Lower limit	31.9	32.4	32.3	32.0	32.0	33.0	31.7	28.6	23.3	22.7
	Upper limit	38.7	38.5	38.3	38.4	38.0	37.8	37.1	35.2	31.5	31.7
Mean corpuscular hemoglobin concentration (g/dL)	n	765	787	819	847	237	196	307	767	654	867
	Lower limit	32.0	32.2	32.3	32.5	32.8	32.7	32.8	32.7	32.3	32.5
	Upper limit	35.4	35.6	35.5	35.7	36.0	36.2	36.6	37.0	36.4	36.6
Red cell distribution width (%)	n	785	813	584	567	273	226	349	516	648	836
	Lower limit	15.0	15.1	15.1	15.0	14.7	14.2	13.9	13.2	11.6	11.8
	Upper limit	19.0	19.3	19.0	18.9	18.7	18.1	18.3	17.6	15.6	16.0
Platelet distribution width (%)	n	493	537	626	560	191	197	354	654	694	917
	Lower limit	15.9	16.1	16.1	16.1	16.3	16.5	16.3	15.9	15.7	15.8
	Upper limit	18.2	18.1	18.4	18.1	18.7	18.6	18.3	18.1	17.6	17.5
Mean platelet volume (fL)	n	403	419	652	649	146	200	158	443	664	887
	Lower limit	6.9	6.9	7.0	6.9	7.0	7.4	7.3	6.7	6.7	6.6
	Upper limit	9.5	9.6	10.0	9.9	10.3	11.1	11.0	10.4	9.7	9.8
Plateletcrit (L/L)	n	406	417	617	597	149	198	191	443	886	666
	Lower limit	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2
	Upper limit	0.3	0.3	0.3	0.3	0.4	0.6	0.5	0.5	0.5	0.5

Table S1. Age and gender-specific reference intervals for hematology analytes (continued).

		6 month - 2 years F	6 month - 2 years M	2 - 6 years F	2 - 6 years M	6 - 12 years F	6 - 12 years M	12 - 18 years F	12 - 18 years M	18 - 40 years F	18 - 40 years M
Monocytes (%)	n	2,596	3,275	4,354	5,402	5,882	6,113	5,506	4,471	23,657	14,439
	Lower limit	4.6	4.9	4.6	4.9	4.7	4.9	4.7	5.2	4.4	4.9
	Upper limit	14.1	14.3	11.9	12.7	11.3	11.7	11.4	12.1	10.9	11.8
Monocytes x 10 <sup>9</sup> /L	n	3,461	2,782	4,666	5,646	5,837	6,471	5,724	4,575	24,039	14,633
	Upper limit	1.6	1.6	1.3	1.3	1.0	1.1	1.0	0.9	0.8	1.0
Eosinophils (%)	n	2,152	2,861	3,508	4,348	4,706	4,921	4,419	3,685	22,068	11,836
	Lower limit	0.2	0.1	0.0	0.1	0.2	0.2	0.1	0.2	0.1	0.2
	Upper limit	7.4	8.9	7.3	9.0	7.4	9.5	5.9	7.7	5.0	6.2
Eosinophils (x 10 <sup>9</sup> /L)	n	2,751	3,442	4,023	5,329	5,565	6,392	5,658	4,655	24,556	22,841
	Upper limit	0.7	0.9	0.6	0.6	0.5	0.8	0.5	0.7	0.4	0.4
Basophils (%)	n	649	836	2,646	3,386	4,468	5,561	5,985	6,253	23,832	14,413
	Upper limit	1.02	0.90	0.80	0.86	0.84	0.93	0.82	0.98	0.96	0.95
Basophils (x 10 <sup>9</sup> /μL)	n	2,625	3,295	4,313	5,421	5,741	5,987	5,341	4,369	22,989	13,576
	Upper limit	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mean corpuscular volume (fL)	n	2,673	3,347	4,409	5,542	6,004	6,187	5,391	4,506	22,813	14,077
	Lower limit	66	63	69	68	72	71	73	73	72	78
	Upper limit	83	82	84	84	87	85	91	91	93	93
Mean corpuscular hemoglobin (pg)	n	2,759	3,485	4,518	5,744	6,180	6,406	5,517	4,658	23,624	14,512
	Lower limit	21.7	20.4	23.3	22.7	24.0	24.0	24.0	24.7	23.8	26.6
	Upper limit	28.8	28.6	29.3	29.1	30.1	29.8	31.6	31.5	32.4	32.5
Mean corpuscular hemoglobin concentration (g/dL)	n	2,738	3,444	4,599	5,720	6,165	6,369	5,612	4,627	23,837	14,699
	Lower limit	32.0	31.7	32.2	32.3	32.4	32.5	32.0	32.5	32.0	32.8
	Upper limit	35.6	35.7	35.7	35.8	35.7	35.8	35.6	35.9	35.5	360.0
Red cell distribution width (%)	n	2,652	3,406	4,396	5,569	5,877	6,151	5,167	4,395	22,213	13,707
	Lower limit	12.5	12.7	12.4	12.6	12.3	12.5	12.2	12.4	12.2	12.3
	Upper limit	17.8	19.0	16.2	16.6	15.3	15.5	15.9	15.3	16.4	14.4
Platelet distribution width (%)	n	2,360	2,984	3,635	4,738	5,151	5,372	4,742	3,940	20,860	12,530
	Lower limit	15.6	15.6	15.6	15.5	15.7	15.7	15.9	15.9	16.0	16.0
	Upper limit	17.2	17.3	17.1	17.1	17.4	17.5	17.7	17.8	17.9	18.0
Mean platelet volume (fL)	n	2,771	3,541	4,630	5,775	6,172	6,482	5,672	4,656	24,424	14,981
	Lower limit	6.5	6.5	6.4	6.4	6.8	6.7	7.2	7.0	7.3	7.1
	Upper limit	9.4	9.4	9.2	9.2	9.8	9.8	10.5	10.3	10.8	10.6
Plateletcrit (L/L)	n	2,818	3,553	4,707	5,876	6,294	9,650	5,754	4,736	24,829	15,150
	Lower limit	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
	Upper limit	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3

Table S1. Age and gender-specific reference intervals for hematology analytes (continued).

		40 - 60 years F	40 - 60 years M	60 - 80 years F	60 - 80 years M	80 - 100 years F	80 - 100 years M
Monocytes (%)	n	22,040	13,937	11,331	8,608	1,690	1,150
	Lower limit	4.5	4.9	4.6	5.2	5.0	5.3
	Upper limit	10.7	11.8	11.6	12.7	12.9	13.0
Monocytes (x 10 <sup>9</sup> /L)	n	22,611	14,607	11,507	9,027	1,704	1,196
	Upper limit	0.8	1.0	0.8	1.1	0.9	0.9
Eosinophils (%)	n	18,885	11,773	9,775	7,552	1,662	1,157
	Lower limit	0.2	0.3	0.2	0.2	0.1	0.2
	Upper limit	5.3	6.2	5.7	6.9	6.0	6.6
Eosinophils (x 10 <sup>9</sup> /L)	n	14,567	14,567	11,785	8,992	1,630	1,191
	Upper limit	0.6	0.6	0.5	0.6	0.4	0.5
Basophils (%)	n	21,664	13,917	11,209	8,736	1,675	1,176
	Upper limit	0.99	1.00	1.00	1.00	1.1	1.0
Basophils (x 10 <sup>9</sup> /μL)	n	22,997	13,678	11,055	8,543	1,683	1,198
	Upper limit	0.1	0.1	0.1	0.1	0.1	0.1
Mean corpuscular volume (fL)	n	21,102	13,578	10,979	8,318	1,634	1,207
	Lower limit	74	78	76	77	76	78
	Upper limit	94	95	95	96	96	99
Mean corpuscular hemoglobin (pg)	n	21,866	14,034	11,535	8,729	1,656	1,213
	Lower limit	24.1	26.3	25.0	25.5	24.8	25.3
	Upper limit	32.2	32.8	32.4	33.0	32.8	34.0
Mean corpuscular hemoglobin concentration (g/dL)	n	22,256	14,096	11,697	8,802	1,632	1,246
	Lower limit	32.0	32.6	32.0	32.1	31.5	31.8
	Upper limit	35.0	35.9	35.3	35.6	35.0	35.4
Red cell distribution width (%)	n	20,463	12,990	10,642	8,007	1,638	1,199
	Lower limit	12.4	12.5	12.6	12.7	11.7	12.8
	Upper limit	16.3	15.0	16.3	16.5	17.6	18.2
Platelet distribution width (%)	n	19,677	12,258	9,940	7,695	1,678	1,240
	Lower limit	16.0	16.0	16.0	16.1	15.9	16.2
	Upper limit	17.9	18.0	17.8	18.1	17.9	18.2
Mean platelet volume (fL)	n	22,887	14,451	11,740	9,038	1,685	1,260
	Lower limit	7.2	7.0	7.2	7.0	7.1	6.9
	Upper limit	10.8	10.6	10.7	10.6	11.0	10.6
Plateletcrit (L/L)	n	23,118	29,781	11,939	9,097	1,690	1,209
	Lower limit	0.1	0.1	0.1	0.1	0.1	0.1
	Upper limit	0.3	0.3	0.4	0.4	0.3	0.3

Gender-specific reference interval within this age partition; +A the number of outliers excluded differed for each partition, the net sample size was slightly different for each parameter.