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Haematological Profiles of Healthy Individuals in Gujarat: A Comprehensive Study of Reference Intervals

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ABSTRACT

Objective: Many factors influence hematological values such as sex, age, ethnic origin, geographic location, season, and genetic disease. This study aims to evaluate and define the reference intervals for hematological parameters in healthy individuals in Gujarat, serving as a benchmark for clinical and diagnostic purposes. **Material and Method:** This retrospective observational study carried out using 2603 healthy individuals' hematological parameters who visited the outpatient department at our institute. Their Hemoglobin, WBC count, Platelets count, Blood Sugar (FBS), S.Creatinine, ALT (SGPT), Cholesterol (Chol), S.HDL Cholesterol, Total Chol HDL Ratio, Triglyceride, VLDL, LDLC, LDL HDL Ratio, Total Lipids. And their Pulse, Systolic BP, Diastolic BP, Height, Weight and BMI were noted. **Result:** Significant differences were observed across age groups and between genders for all parameters. Hemoglobin levels varied significantly ($p = 0.0014$), with the 51-60 age group having the highest mean (13.9 ± 1.63) and the >60 age group the lowest (13.23 ± 1.69). WBC count also varied ($p = 0.0489$), peaking in the 21-30 age group (7.44 ± 1.76) and lowest in the 41-50 age group (6.89 ± 1.71). Platelet count showed highly significant differences ($p < 0.0001$), decreasing with age, from 315.52 ± 73.11 in 21-30 to 279.53 ± 61.31 in 51-60, before slightly increasing in >60 (293.27 ± 72.41). These findings were compared with studies defining hematological reference intervals in Indian populations, showing some similarities but also highlighting regional differences. **Conclusion:** These findings highlight age- and gender-specific variations, reinforcing the need for tailored clinical reference ranges.

KEY WORDS: Haematological Profiles, Healthy Individuals, Clinical laboratory test

Introduction

The concept of reference intervals was introduced by international federation of clinical chemistry (IFCC) to address challenges associated with normal values and values obtained from an individual under clinical investigation [1].

Reference values (or normal values) for haematological parameters are essential for aiding physicians in interpreting clinical measurements. These parameters are influenced by various factors such as age, ethnicity, diet, genetic and gender differences. Thus, it is crucial to define the specific reference values concerning age, gender and the region [2-5].

In Gujarat, a diverse state in western India, has a unique demographic and genetic composition, which may affect haematological profiles. Variations in lifestyle, nutrition, and climatic conditions contribute to differences in blood parameters among the population. However, comprehensive data on the haematological profiles of healthy individuals in Gujarat remains limited. Establishing region-specific reference values is essential for improving diagnostic accuracy and understanding population-specific health trends.

Hematological and biochemical parameters such as Hemoglobin, WBC count, Platelet count, and Blood Sugar levels play a vital role as benchmarks for clinical diagnosis, drug selection, disease risk assessment, disease staging, treatment monitoring and research [6-7]. Several studies have emphasized the importance of establishing population-specific reference intervals for

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hematological parameters. This study aims to evaluate and define the reference intervals for hematological parameters in healthy individuals in Gujarat, serving as a benchmark for clinical and diagnostic purposes.

Methods

This is a retrospective observational study. Institutional Ethics committee approval was obtained before the study (EC/Approval/24/Pathology /10/10/2024). Since the study is retrospective in nature, informed consent was waived by the ethics committee. Data from 2603 healthy individuals who visited the outpatient department of tertiary care hospital for routine health evaluation under the health checkup category were included in the study. These individuals were clinically asymptomatic and apparently healthy. The following blood examinations were performed for all study samples: Hemoglobin, WBC count, Platelets count, Blood Sugar (FBS), S.Creatinine, ALT (SGPT), Cholesterol (Chol), S.HDL Cholesterol, Total Chol HDL Ratio, Triglyceride, VLDL, LDLC, LDL HDL Ratio, Total Lipids. And their Pulse, Systolic BP, Diastolic BP, Height, Weight and BMI were noted.

The study included healthy individuals both male and female, aged between 18 and 60 years who were residents of Gujarat with no history of chronic diseases or any condition that could affect blood parameters. Eligible subjects had to meet specific laboratory criteria, including cholesterol levels below 250 mg/dL, triglyceride levels below 170 mg/dL, LDL levels below 180 mg/dL, a body mass index (BMI) of 30 kg/m² or less, and hemoglobin levels greater than 10 gm/dL.

Individuals were excluded if they had renal failure, cardiac diseases, chronic respiratory conditions, liver diseases, malabsorption syndromes, malignancies, or hematological disorders including anemias. Even participants with history of systemic diseases such as hypertension or diabetes mellitus were also excluded. Additionally, individuals with chronic intake of pharmacologically active substances, such as alcohol, tobacco, or oral contraceptives, were not eligible. Those undergoing replacement or supplementation therapy, including medications like thyroxine or insulin, were excluded as well. Pregnant women and individuals with psychological or mental disorders were not considered for inclusion.

Statistical Analysis

All statistical analyses were conducted using SPSS version 26. Descriptive statistics (mean ± SD) were calculated. ANOVA was applied to assess variations across age groups, and independent t-tests were used for gender comparisons. A p-value <0.05 was considered statistically significant. Findings were compared with established reference intervals from previous studies conducted in India [8].

Results

The mean, median, standard deviation, range (minimum–maximum value) of all the parameters of healthy individuals are shown in [Table. 1]

Comparison of all the variables in terms of male and female are shown in [Table. 2]. The mean platelets count was significantly higher in females (337.16 ± 79.76) as compared to males (286.35 ± 63.08), fasting blood sugar found significantly more in male (96.2 ± 24.56 mg/dl) as compared to female (87.55 ± 16.53). Total Cholesterol value found more in male (179.66 ± 30.73) compared to female (173.69 ± 31.18). Good cholesterol (HDL) found significantly more in female (45.06 ± 8.6) as compared to male (39.25 ± 7.49). Total lipids found significantly more in male (617.87 ± 53.22) as compared to female (599.63 ± 53.81). In terms of blood pressure, Systolic and diastolic pressure found significantly high in male (128.55 ± 14.5, 82.16 ± 9.35) as compared to female (115.6 ± 13.89, 76.19 ± 9.11).

The study revealed notable age-related changes in various blood parameters and health indicators across both genders. Regarding hemoglobin levels, males showed a significant decline with advancing age, decreasing from an average of 14.56 gm/dL in the 21–30 years group to 13.3 gm/dL in those over 60 years ($p < 0.001$). In contrast, females exhibited a less marked decline, with levels slightly increasing from 11.95 gm/dL in young adulthood to 12.53 gm/dL in the over-60 age group ($p = 0.0249$).

For white blood cell (WBC) count, no clear trend was observed in either gender, and the changes across age groups were not statistically significant. Platelet counts, however, showed significant declines with age in males ($p < 0.001$), while females experienced only minor fluctuations that were not statistically significant ($p = 0.5395$).

Fasting blood sugar (FBS) levels increased significantly with age in both males and females ($p < 0.001$), indicating a progressive risk of impaired glucose metabolism. Serum creatinine levels in males exhibited a slight increase until the 51–60 years age group, followed by a decline in those over 60, whereas females maintained relatively stable creatinine levels throughout.

Liver enzyme levels, particularly ALT (SGPT), peaked in males within the 31–40 years age group and declined thereafter. For females, no significant changes with age were observed in ALT levels.

Table 1: Mean, median, standard deviation, range (minimum–maximum value) of all the parameters

Variable	Mean	Median	Std. Deviation	Minimum	Maximum
Haemoglobin (gm/dl)	13.74	14	1.75	10.8	18.7
WBC count (/ cumm)	7.26	7.02	3.72	2.94	176
Platelets count (/ cumm)	298.07	291	70.59	51	691
Blood Sugar (FBS) (mg/dl)	94.21	91	23.24	64	377
S.Creatinine (mg/dl)	0.87	0.87	0.2368	0.43	6.03
ALT (SGPT) (U/L)	25.52	21	16.25	2	246
Cholesterol (Chol) (mg/dl)	178.29	178	30.93	72	250
S.HDL Cholesterol (mg/dl)	40.59	40	8.13	6	83
Total Cholesterol HDL Ratio (mg/dl)	4.53	4.47	1.059	1.64	17.17
Triglyceride (mg/dl)	94.79	91	33.32	20	170
VLDL (mg/dl)	18.95	18.2	6.66	4	34
LDLC (mg/dl)	118.74	118.8	27.56	24	180
LDL HDL Ratio (mg/dl)	3.034	2.99	0.9	0.55	12.57
Total Lipids (mg/dl)	613.67	613	53.89	436	759
Pulse	79.71	79	11.81	45	146
Systolic BP (mmHg)	125.56	125	15.35	60	210
Diastolic BP (mmHg)	80.78	80	9.62	46	120
Height (cm)	168.27	169	8.55	140	196
Weight (kg)	69.46	70	11.37	23.8	111
BMI	24.46	24.57	3.1	7.43	30.96

Table 2: Comparison of all the variables in terms of male and female

Variable	Male, N=2003	Female, N=600	p-Value
Haemoglobin (gm/dl)	14.3 ± 1.47	11.91 ± 1.29	<0.001
WBC count (/ cumm)	7.13 ± 4.11	7.74 ± 1.92	<0.0013
Platelets count (/ cumm)	286.35 ± 63.08	337.16 ± 79.76	<0.001
Blood Sugar (FBS) (mg/dl)	96.2 ± 24.56	87.55 ± 16.53	<0.001
S.Creatinine (mg/dl)	0.93 ± 0.23	0.68 ± 0.12	<0.001
ALT (SGPT) (U/L)	28.05 ± 16.82	17.04 ± 10.4	<0.001
Cholesterol (Chol) (mg/dl)	179.66 ± 30.73	173.69 ± 31.18	<0.001
S.HDL Cholesterol (mg/dl)	39.25 ± 7.49	45.06 ± 8.6	<0.001
Total Cholesterol HDL Ratio (mg/dl)	4.7 ± 1.04	3.96 ± 0.9	<0.001
Triglyceride (mg/dl)	98.96 ± 32.77	80.89 ± 31.37	<0.001
VLDL (mg/dl)	19.79 ± 6.55	16.18 ± 6.27	<0.001
LDLC (mg/dl)	120.62 ± 27.37	112.46 ± 27.29	<0.001
LDL HDL Ratio (mg/dl)	3.17 ± 0.9	2.58 ± 0.77	<0.001
Total Lipids (mg/dl)	617.87 ± 53.22	599.63 ± 53.81	<0.001
Pulse	78.6 ± 11.95	83.45 ± 10.55	<0.001
Systolic BP (mmHg)	128.55 ± 14.5	115.6 ± 13.89	<0.001
Diastolic BP (mmHg)	82.16 ± 9.35	76.19 ± 9.11	<0.001
Height (cm)	171.56 ± 6.11	157.31 ± 6.06	<0.001
Weight (kg)	72.7 ± 9.99	58.67 ± 8.76	<0.001
BMI	24.69 ± 3.05	23.73 ± 3.39	<0.001

In terms of cholesterol and lipid profiles, male cholesterol levels remained stable across all age groups, while females experienced a significant increase with age ($p < 0.001$), with higher LDL levels noted after menopause.

Blood pressure (BP) showed a significant upward trend with age in both genders ($p < 0.001$), suggesting heightened cardiovascular risk as individuals age. Finally, BMI and body weight patterns differed between genders: males showed an increase in BMI with age, peaking in middle age before slightly declining after 60 years, whereas females displayed significant weight gain over time. These findings collectively highlight how age influences metabolic and physiological parameters differently in males and females. [Table. 3] represents the trends of all parameters with age.

Table 3: Trends of all parameters with age

Age Group	Variable	Male	Female	p-Value
21-30	Haemoglobin (gm/dl)	14.56 ± 1.28	11.95 ± 1.23	<0.001
	WBC count (/ cumm)	7.21 ± 1.58	7.8 ± 1.97	<0.001
	Platelets count (/ cumm)	301.74 ± 64.64	336.62 ± 80.1	<0.001
	Blood Sugar (FBS) (mg/dl)	87.61 ± 11.4	84.88 ± 9.54	0.002
	S.Creatinine (mg/dl)	0.89 ± 0.14	0.69 ± 0.12	<0.001
	ALT (SGPT) (U/L)	28.51 ± 16.39	17.08 ± 11.36	<0.001
	Cholesterol (Chol) (mg/dl)	178.37 ± 29.86	165.46 ± 29.05	<0.001
	S.HDL Cholesterol (mg/dl)	39.57 ± 7.35	44.63 ± 7.78	<0.001
	Total Cholesterol HDL Ratio (mg/dl)	4.64 ± 1.06	3.79 ± 0.77	<0.001
	Triglyceride (mg/dl)	94.07 ± 32.46	74.81 ± 29.92	<0.001
	VLDL (mg/dl)	18.81 ± 6.49	14.96 ± 5.98	<0.001
	LDLC (mg/dl)	119.99 ± 26.62	105.87 ± 24.84	<0.001
	LDL HDL Ratio (mg/dl)	3.14 ± 0.92	2.43 ± 0.66	<0.001
	Total Lipids (mg/dl)	612.01 ± 54.08	584.9 ± 51.11	<0.001
	Pulse	78.64 ± 11.23	83.4 ± 10.43	<0.001
	Systolic BP (mmHg)	125.09 ± 11.74	112.31 ± 11.05	<0.001
	Diastolic BP (mmHg)	79.66 ± 8.23	74.22 ± 8.01	<0.001
	Height (cm)	171.61 ± 6.29	157.96 ± 5.52	<0.001
	Weight (kg)	69.83 ± 10.56	56.13 ± 7.81	<0.001
	BMI	23.69 ± 3.16	22.52 ± 3.13	<0.001
31-40	Haemoglobin (gm/dl)	14.44 ± 1.39	11.85 ± 1.33	<0.001
	WBC count (/ cumm)	7.3 ± 6.36	7.73 ± 1.91	0.296
	Platelets count (/ cumm)	291.39 ± 60.18	341.56 ± 80.26	<0.001
	Blood Sugar (FBS) (mg/dl)	92.22 ± 16.08	86.69 ± 12.57	<0.001
	S.Creatinine (mg/dl)	0.92 ± 0.16	0.67 ± 0.11	<0.001
	ALT (SGPT) (U/L)	31.68 ± 20.84	16.31 ± 9.24	<0.001
	Cholesterol (Chol) (mg/dl)	179.95 ± 30.05	173.7 ± 29.39	0.004
	S.HDL Cholesterol (mg/dl)	39.32 ± 7.68	44.73 ± 9.06	<0.001
	Total Cholesterol HDL Ratio (mg/dl)	4.71 ± 1.03	4.02 ± 0.97	<0.001
	Triglyceride (mg/dl)	100.77 ± 34.56	81.81 ± 31.21	<0.001
	VLDL (mg/dl)	20.15 ± 6.91	16.36 ± 6.24	<0.001
	LDLC (mg/dl)	120.48 ± 26.75	112.61 ± 27.07	<0.001
	LDL HDL Ratio (mg/dl)	3.17 ± 0.88	2.63 ± 0.84	<0.001
	Total Lipids (mg/dl)	620.04 ± 54.06	600.25 ± 50.27	<0.001
	Pulse	78.73 ± 11.68	83.84 ± 10.57	<0.001
	Systolic BP (mmHg)	127.71 ± 13.51	114.91 ± 12.32	<0.001
	Diastolic BP (mmHg)	82.15 ± 9.14	76.85 ± 9.56	<0.001
	Height (cm)	172.1 ± 5.99	156.69 ± 5.96	<0.001
	Weight (kg)	72.28 ± 9.96	59.6 ± 8.39	<0.001
	BMI	24.39 ± 3.04	24.3 ± 3.26	0.700
41-50	Haemoglobin (gm/dl)	14.14 ± 1.54	11.73 ± 1.36	<0.001
	WBC count (/ cumm)	6.77 ± 1.66	7.74 ± 1.85	<0.001
	Platelets count (/ cumm)	273.55 ± 64.63	331.13 ± 75.11	<0.001

Age Group	Variable	Male	Female	p-Value
	Blood Sugar (FBS) (mg/dl)	100.51 ± 25.44	96.25 ± 32.68	0.178
	S.Creatinine (mg/dl)	0.96 ± 0.27	0.68 ± 0.12	<0.001
	ALT (SGPT) (U/L)	25.25 ± 11.37	18.48 ± 10.64	<0.001
	Cholesterol (Chol) (mg/dl)	180.86 ± 31.26	192.41 ± 31	0.002
	S.HDL Cholesterol (mg/dl)	38.85 ± 7.14	46.4 ± 9.24	<0.001
	Total Cholesterol HDL Ratio (mg/dl)	4.78 ± 1.1	4.26 ± 0.92	<0.001
	Triglyceride (mg/dl)	98.88 ± 31.74	89.59 ± 31.13	0.014
	VLDL (mg/dl)	19.78 ± 6.35	17.92 ± 6.23	0.014
	LDLC (mg/dl)	122.24 ± 27.53	128.1 ± 26.67	0.075
	LDL HDL Ratio (mg/dl)	3.24 ± 0.93	2.85 ± 0.79	<0.001
	Total Lipids (mg/dl)	618.6 ± 53.04	628.4 ± 52.63	0.122
	Pulse	77.39 ± 11.77	83.69 ± 10.53	<0.001
	Systolic BP (mmHg)	128.52 ± 15.86	123.3 ± 17.34	0.007
	Diastolic BP (mmHg)	82.96 ± 9.46	78.68 ± 9.62	<0.001
	Height (cm)	171.34 ± 6.06	157.27 ± 6.82	<0.001
	Weight (kg)	74.89 ± 9.18	62.45 ± 9.91	<0.001
	BMI	25.5 ± 2.78	25.2 ± 3.3	0.381
	Haemoglobin (gm/dl)	13.99 ± 1.63	12.72 ± 1	0.001
	WBC count (/ cumm)	7.23 ± 1.62	7.31 ± 1.83	0.843
	Platelets count (/ cumm)	277.13 ± 58.44	312.75 ± 87.73	0.012
	Blood Sugar (FBS) (mg/dl)	109.77 ± 41.83	96.75 ± 20.43	0.169
	S.Creatinine (mg/dl)	0.98 ± 0.36	0.71 ± 0.16	0.001
	ALT (SGPT) (U/L)	23.96 ± 12.36	18.7 ± 9.92	0.064
	Cholesterol (Chol) (mg/dl)	178.42 ± 32.48	199.1 ± 35.69	0.007
	S.HDL Cholesterol (mg/dl)	39.38 ± 7.88	49.6 ± 9.22	<0.001
	Total Cholesterol HDL Ratio (mg/dl)	4.64 ± 0.95	4.11 ± 0.93	0.017
	Triglyceride (mg/dl)	100.91 ± 29.52	106.8 ± 30.93	0.391
51-60	VLDL (mg/dl)	20.18 ± 5.9	21.36 ± 6.19	0.391
	LDLC (mg/dl)	118.85 ± 29.34	128.14 ± 31.66	0.175
	LDL HDL Ratio (mg/dl)	3.1 ± 0.86	2.65 ± 0.8	0.024
	Total Lipids (mg/dl)	618.71 ± 49.79	655.5 ± 51.8	0.002
	Pulse	79.45 ± 12.43	78.55 ± 11.46	0.754
	Systolic BP (mmHg)	134.38 ± 15.23	131.8 ± 20.88	0.477
	Diastolic BP (mmHg)	83.96 ± 10.11	82 ± 7.3	0.396
	Height (cm)	170.94 ± 6.11	156.6 ± 8.84	<0.001
	Weight (kg)	74 ± 9.46	62.79 ± 10.18	<0.001
	BMI	25.31 ± 2.85	25.65 ± 3.77	0.618
>60	Haemoglobin (gm/dl)	13.3 ± 1.75	12.53 ± 0.71	0.465
	WBC count (/ cumm)	7.45 ± 1.42	7.35 ± 1.83	0.913
	Platelets count (/ cumm)	288.17 ± 70.02	344.33 ± 92.29	0.205
	Blood Sugar (FBS) (mg/dl)	100.23 ± 23.83	86.33 ± 4.73	0.328
	S.Creatinine (mg/dl)	0.89 ± 0.18	0.57 ± 0.05	0.004
	ALT (SGPT) (U/L)	21.7 ± 10.23	25 ± 12.17	0.603
	Cholesterol (Chol) (mg/dl)	178.03 ± 33.11	189.67 ± 23.8	0.560
	S.HDL Cholesterol (mg/dl)	39.63 ± 7.17	41.33 ± 4.93	0.693
	Total Cholesterol HDL Ratio (mg/dl)	4.6 ± 1.06	4.62 ± 0.69	0.981
	Triglyceride (mg/dl)	99.4 ± 33.57	106 ± 26.51	0.745
	VLDL (mg/dl)	19.88 ± 6.71	21.2 ± 5.3	0.745
	LDLC (mg/dl)	118.52 ± 30.79	127.13 ± 20.17	0.641
	LDL HDL Ratio (mg/dl)	3.08 ± 0.94	3.11 ± 0.65	0.953
	Total Lipids (mg/dl)	617.07 ± 53.49	637 ± 50.39	0.541

Age Group	Variable	Male	Female	p-Value
	Pulse	89.3 ± 18.82	81.33 ± 12.74	0.482
	Systolic BP (mmHg)	140.23 ± 15.87	136.33 ± 30.01	0.710
	Diastolic BP (mmHg)	82.97 ± 12.2	81.33 ± 17.62	0.832
	Height (cm)	167.07 ± 5.27	159.67 ± 12.01	0.048
	Weight (kg)	66.56 ± 10.26	65.33 ± 11.93	0.846
	BMI	23.83 ± 3.42	25.46 ± 1.78	0.427

Discussion

Clinical laboratory test interpretation is heavily dependent on appropriate and accurate Reference Interval. This study provides crucial data on the haematological profiles of a healthy population in Gujarat, demonstrating clear trends based on age and gender [9-11].

Haemoglobin Levels

In our study males, hemoglobin levels show a statistically significant decline with age, decreasing from an average of 14.56 gm/dL in the 21-30 age group to 13.3 gm/dL in individuals older than 60 years (p = <0.001). This decrease may be attributed to factors such as reduced bone marrow activity, chronic inflammation, and possible micronutrient deficiencies that commonly occur with aging.

In females, the decline in hemoglobin levels is less marked, with a slight increase from 11.95 gm/dL in young adulthood to 12.53 gm/dL in those over 60 years (p= 0.0249). This mild but significant trend may be influenced by hormonal changes post-menopause, leading to better iron retention compared to premenopausal women.

A similar cross-sectional study was conducted by Fan Su and his colleague, in the 303,084 participants, the average age for females (15–98) and males (14–98) years respectively. The results showed that hemoglobin levels increased up to age 25 and then decreased in men; in women the levels increased up until age 20, and then decreased, with slight increase again ($\beta = 0.244$, $p < 0.01$). After dividing all participants into hyperglycemia and normal groups, only the normal female group showed a significant upward trend ($\beta = 0.257$, $P < 0.01$) between ages 50–59 [12].

BMI & Weight

In males, BMI and weight tend to increase with age, peaking in middle age but slightly declining after 60 years. In females, there is significant weight gain over time, which increases the risk of obesity-related health complications. These trends emphasize the importance of weight management strategies in aging populations to mitigate obesity-associated risks such as diabetes, cardiovascular disease, and joint disorders.

White Blood Cell (WBC) Count

There is no clear trend in WBC counts across different age groups for both males and females. The P-values indicate that there are not statistically significant, suggesting that immune function, as reflected by WBC count, remains relatively stable with age in healthy individuals. Similar multicentre study conducted in 13 cities across Korea (Seoul, Incheon, Suwon, Chuncheon, Chungju, Daejeon, Daegu, Jeonju, Gwangju, Woolsan, Busan, Changwon, and Jeju). In their study total 8,04,623 healthy individual's CBC data were retrospectively obtained from health checkups of individuals aged 3–99 years. Findings shows that WBC count differed with sex but not with age [13].

Platelet Count

In males, platelet counts show a statistically significant decline with age (301.74 at 21-30 years to 288.17 at >60 years, p= <0.0010). This decrease could be related to changes in bone marrow activity or increased platelet consumption due to age-related vascular changes. While in females, platelet counts exhibit minor fluctuations without a clear declining trend, and the changes are not statistically significant (p= 0.5395). This suggests that platelet homeostasis remains largely stable in aging women. The above multicentric study found that the platelet count was higher in females (except in childhood) and decreased with age in both sexes [13].

Blood Sugar (Fasting Blood Sugar - FBS)

The prevalence of diabetes increased with age and reached the peak at 70-89 years of age in Chinese and Japanese subjects but peaked at 60-69 years of age followed by a decline at the 70 years of age in Indian subjects [14]. In our study both males and females experience a significant increase in fasting blood sugar levels with aging. In males, FBS rises from 87.61 mg/dLat 21-30 years to 100.23 mg/dL at >60 years (p = <0.001), while in females, it increases from 84.88 mgm/dL to 96.75 mg/dL (p= <0.001). This trend shows the higher risk of diabetes or impaired glucose metabolism in older adults, possibly due metabolic changes associated with aging. Fasting glucose levels generally increased with age and were higher in men compared with women, consistent with previous research [14, 15].

Serum Creatinine

The epidemiology of chronic kidney disease (CKD) differs by sex. Serum creatinine levels in males show a slight increase until the 51-60 age group, followed by a decline in those older than 60 years. In females, creatinine levels

remain relatively stable with no significant trend (P = 0.1467). These findings suggest that kidney function in males may decline slightly with age, but the compensatory mechanisms help maintain stability in females.

ALT (SGPT - Liver Enzyme)

In males, ALT levels peak at 31-40 years (31.68 U/L) and then decline with age. In females, there are no significant changes in ALT levels with age. This indicates that liver enzyme variations are more pronounced in males, possibly reflecting lifestyle factors such as alcohol consumption or metabolic stress in middle age.

Cholesterol & Lipids

Lipid and cholesterol levels differ between genders and change with age, with men experiencing an increase in LDL cholesterol and total cholesterol with age, while women experience a rise in LDL cholesterol and total cholesterol after menopause. Men tend to have higher total cholesterol and lower HDL cholesterol levels compared to women until mid-life, but after menopause, women's lipid profiles change [16]. In our study male's cholesterol levels remain relatively stable across different age groups. However, in females, there is a significant increase in cholesterol levels with aging (165.46 mgm/dLat 21-30 years to 199.1 mgm/dLat >60 years, p=<0.001). Additionally, HDL (good cholesterol) levels are higher in females than in males, while LDL (bad cholesterol) levels increase with age in females (p= <0.001). This indicates that postmenopausal women are at a higher risk for cardiovascular diseases due to increased LDL levels and overall lipid profile alterations.

Blood Pressure (BP)

It is well documented in the literature that BP profiles change with age [17]. In our study Both systolic and diastolic blood pressure increase significantly with age in both genders. In males, systolic BP rises from 125 mmHg in the 21-30 age group to 140 mmHg in those older than 60 years (p= <0.001). Similarly, in females, systolic BP increases from 112 mmHg to 136 mmHg (p =<0.001). This trend highlights the increasing risk of hypertension with aging, necessitating lifestyle and medical interventions to manage cardiovascular health.

Clinical Implication

- Haemoglobin level decrease with age, requiring age-adjusted diagnostic criteria.
- Increasing blood sugar and cholesterol level highlight the need for preventive healthcare strategies.
- Postmenopausal women are at higher risk for cardiovascular disease due to increased LDL cholesterol level.
- Hypertension risk rises significantly with age, necessitating regular BP monitoring in older individuals.

Conclusion

The data reflect significant age-related changes in hematological and metabolic parameters. Blood sugar, cholesterol, and blood pressure increase with age, indicating higher risks of diabetes, heart disease, and hypertension. Males show more fluctuations in kidney and liver function markers, while females experience more changes in lipid profiles and BMI. Platelet count decreases with age in men but remains relatively stable in women.

These findings underscore the importance of establishing region-specific reference interval for improved clinical decision-making in Gujarat.

Strengths

- Large sample size: In this retrospective study total 2603 healthy individual's data included which improves statistical reliability and representation of the population.
- Gender and Age based analysis –Our study presents the gender age based hematological parameters that helps in identifying sex and age specific differences.

Limitations

- Single-center population: This is a single-center design; this may limit the generalizability of findings to other clinical settings.
- Cross-sectional design – In this study we collected only one-time values; repeat variations are not assessed.
- Healthy volunteer bias – Only "apparently healthy" individuals were included in this study, so may not reflect subclinical conditions.

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References

1. Solberg HE. Approved recommendation (1986) on the theory of reference values. Part 1. The concept of reference values. Journal of clinical chemistry and clinical biochemistry. 1987; 25 (5): 337-342.
2. Sharper AG, Lewis P. Genetic neutrophenia in people of African origin. The Lancet. 1971; 298(7732):1021-1023. Available from: https://doi.org/10.1016/s0140-6736(71)90335-7
3. Woodliff HJ, Kataaha PK, Tibaleka AK, Nzaro E. Total leucocyte count in Africans. The Lancet. 1972; 300(7782):875. Available from: https://doi.org/10.1016/s0140-6736(72)92236-2

4. Garn SM, Smith NJ, Clark DC, Life-long differences in haemeoglobin levels between blacks and withes. Journal of the National Medical Association., 1975; 67(2): 91-96. https://pubmed.ncbi.nlm.nih.gov/1133873/
5. William DM. Racial differences of hemoglobin concentration: measurements of iron, copper, and zinc. The American Journal of Clinical Nutrition. 1981; 34(9):1694-1700. Available from: https://doi.org/10.1093/ajcn/34.9.1694
6. Martinez-Sanchez L, Marques-Garcia F, Ozarda Y, Blanco A, Brouwer N, Canalias F, *et al*. Big data and reference intervals: rationale, current practices, harmonization and standardization prerequisites and future perspectives of indirect determination of reference intervals using routine data. Advances in Laboratory Medicine / Avances en Medicina de Laboratorio. 2021; 2(1):9-16. Available from: https://doi.org/10.1515/almed-2020-0034
7. Xu P, Zhou Q, Xu J. Reference interval transference of common clinical biomarkers. Scandinavian Journal of Clinical and Laboratory Investigation. 2021; 81(4):264-271. Available from: https://doi.org/10.1080/00365513.2021.1907858
8. Sairam S, Domalapalli S, Muthu S, Swaminathan J, Ramesh VA, Sekhar L, *et al*. Hematological and Biochemical Parameters in Apparently Healthy Indian Population: Defining Reference Intervals. Indian Journal of Clinical Biochemistry. 2014; 29(3):290-297. Available from: https://doi.org/10.1007/s12291-013-0365-5
9. 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. https://doi.org/10.1371/journal.pone.0004401
10. Zeh C, Amornkul PN, Inzaule S, Ondoa P, Oyaro B, Mwaengo DM, *et al*. Population-Based Biochemistry, Immunologic and Hematological Reference Values for Adolescents and Young Adults in a Rural Population in Western Kenya. PLoS ONE. 2011; 6(6):e21040. Available from: https://doi.org/10.1371/journal.pone.0021040
11. M Pekelharing J, Hauss O, De R, Lokhoff J, Sodikromo J, Spaans M, et al. Haematology Reference Intervals for Established and Novel Parameters in Healthy Adults 2010. Diagnostic Perspectives 1, 2010. 1-11. https://pure.eur.nl/en/publications/haematology-reference-intervals-for-established-and-novel-paramet
12. Su F, Cao L, Ren X, Hu J, G T, Wu H, *et al*. Age and sex trend differences in hemoglobin levels in China: a cross-sectional study. BMC Endocrine Disorders. 2023; 23(1):8. Available from: https://doi.org/10.1186/s12902-022-01218-w
13. Nah EH, Kim S, Cho S, Cho HI. Complete Blood Count Reference Intervals and Patterns of Changes Across Pediatric, Adult, and Geriatric Ages in Korea. Annals of Laboratory Medicine. 2018; 38(6):503-511. Available from: https://doi.org/10.3343/alm.2018.38.6.503
14. 14. Qiao Q, Hu G, Tuomilehto J, Nakagami T, Balkau B, Borch-Johnsen K, *et al*. DECODA Study Group. Age- and sex-specific prevalence of diabetes and impaired glucose regulation in 11 Asian cohorts. Diabetes Care. 2003; 26(6):1770-1780. Available from: https://doi.org/10.2337/diacare.26.6.1770
15. DECODE Study Group, *et al*. Age- and sex-specific prevalences of diabetes and impaired glucose regulation in 13 European cohorts. Diabetes Care. 2003; 26(1):61-69. Available from: https://doi.org/10.2337/diacare.26.1.61
16. Holven KB, van Lennep JR. Sex differences in lipids: a life course approach. Atherosclerosis. 2023; 384:117270. Available from: https://doi.org/10.1016/j.atherosclerosis.2023.117270
17. Franklin SS, Gustin W, Wong ND, Larson MG, Weber MA, Kannel WB, Levy D. Hemodynamic Patterns of Age-Related Changes in Blood Pressure. Circulation. 1997; 96(1):308-315. Available from: https://doi.org/10.1161/01.CIR.96.1.308

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