CLINICO-HEMATOLOGICAL PROFILE OF ANEMIA IN INFANTS AND CHILDREN: A CROSS-SECTIONAL STUDY.

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Abstract
Introduction
Anemia is characterized by decreased hemoglobin levels it is widely prevalent around the world. It is reported amongst women within 13-50 years of age group and among the pediatric population. Therefore, the present study aimed to find a correlation between first-digit fingerprint patterns and retinal vascular patterns.

Material and Methods
The study included 100 patients with suspected anemias who are infants or children (up to the age of 14). Digital photographs of the fundus of both eyes were taken using a Zeiss Visucamlite fundus camera. Data from the retinal vascular patterns and first-digit prints were compiled and analyzed for correlations.

Results
The study found that 39% of subjects had loop patterns, 36.5% had whorls, and 1.5% had arches on their first digit. Retinal vasculature was more extensive on the temporal side in 87.5% of subjects. Subjects with loops on both thumbs had a higher mean number of branches in the superotemporal quadrant of the left eye (mean = 9.36 ± 3.12), while those with whorls had more branches in the superotemporal quadrant of the right eye (mean = 9.34 ± 2.87). Additionally, the mean number of branches in the inferior temporal arteries for the right eye (7.37 ± 2.43) and left eye (7.35, ± 2.8) of participants with loop patterns was higher than in other quadrants.

Conclusions
Among 100 pediatric patients studied, Anemia was prevalent in children below 5 years. Children with a male preponderance aplastic anemia were most common among the 10-14 years age group. For optimal treatment of anemia, multiple facets should be addressed. An integrated approach can help in dealing with this disease.

Recommendations
Further research using advanced biometric tools is recommended to explore the causal relationship between fingerprint patterns and retinal vascular branching, potentially enhancing the efficacy and reliability of biometric identification methods.

Introduction
Anemia is characterized by decreased hemoglobin levels it is widely prevalent around the world. It is reported amongst women within 13-50 years of age group and among the pediatric population2. It has severe health consequences and it affects the social and economic growth of the country as well. It is known that 20% of the pediatric population below 5 years in an industrialized country suffers from anemia and 39% of the population in a non-industrialized country suffers from anemia[1]. Anemia is defined as a reduction of the hemoglobin compared to the normal ranges. Packed cell volume and hemoglobin levels vary significantly with age, gender, and race 3. The pediatric population with anemia has decreased hemoglobin levels but is asymptomatic. A detailed analysis of history can aid in unraveling the primary cause[4]. Anemia due to lack of nutrition is prevalent in countries like India as there are high incidences of malnutrition, economic inadequacy, lack of good dietary practices, and parasitic infection. In developing countries, 51% of the below 4 years of age and 46% of those between 5 to 12 years of age are anemic [5][6]. The presence of anemia indicates the nutritional status of the children nationwide. Considering developed countries like the US where 18% of the pediatric population suffers from anemia as compared to 82% of the population in

developing countries[4].Thus studying the prevalence of anemia and the symptoms associated with it in developing countries like India is essential [7] [8].

Placenta stores are easily replenished until the first six months of life. Thus, anemia is very rare below six months.Glucose-6- phosphate dehydrogenase (G6PD) deficiencies are common amongst male gender. Habits Pica or geophagia usually result in iron deficiency. Drug use can influence deficiency of G6PD and it can also cause aplastic anemia. If diarrhea occurs frequently it indicates that the absorption from the intestine is not optimum which can cause growth, a cardiac murmur, and glossitis. Anemia if occurs acutely can manifest even cardiac failure, apart from it diarrhea, tachycardia, tachypnoea, haematuria, splenomegaly, and jaundice can occur.

During screening the patients undergo a complete blood cell count to diagnose anemia. Anemia based on the appearance of cells can be microcytic, normocytic, and macrocytic. Peripheral smear and reticulocyte counting are also done in such cases. Smears help in understanding the exact morphology of the cells. Clumping of the ribosome that is stippling basophils is seen in thalassemia, lead poisoning, and iron deficiency. The fragments of the nucleus are seen when there is severe anemia deficiency and when the is aplastic anemia present. The percentage of reticulocytes indicates the formation and destruction rate of RBC. In case of decreased formation of RBC, the count decreases whereas in case of destruction, the count increases. Co.[4] [9] [10] Anemia most prevalent iron deficiency-related health complexity in India. As per NHFS 2016 data 56% of the paediatric population suffers from anemia, and 53% and 50% of pregnant and non-pregnant women suffer from anemia (NFHS)[11].

The present study aimed to find a correlation between first-digit fingerprint patterns and retinal vascular patterns.

Materials and methods
Study design
Prospective cross-sectional study.

Study area
The study took place at Patna Medical College and Hospital, Patna (Department of Pathology and Department of Paediatrics) spanning from January 2020 to March 2022.

Study population
The study subject included 100 patients with suspected anemia who are infants or children (up to the age of 14) attending the OPD and Emergency of the Department of Paediatrics at Patna Medical College and Hospital, Patna, and willing to take part in the study.

Sample size
To calculate the sample size for this study, the following formula was used for estimating a proportion of a population:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where:
- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

A detailed history was elicited, a thorough clinical examination was undertaken and data was recorded in the proforma. The required quantity of venous blood was collected in EDTA tubes. The collected blood was analyzed using Sysmex KX- 21, an automated cell counter having three-part differentials.

The following parameters were obtained by the automated cell counter.

- Hb%
- PCV
- RBC count
- RBC indices including MCV, MCH, MCHC
- RDW
- Platelet count
- Total WBC count including the differential count.

Peripheral smears were prepared on clean glass slides and stained with Leishman's stain. Reticulocyte count was done by the supravital staining technique using Brilliant cresyl blue.

Inclusion Criteria
- Infants and children (up to the age of 14) will be included.
- Participant's Hb level should be below the lower limit of the normal Hb range for his/her respective age and will be considered

Exclusion Criteria
- All children with malignancy and leukemia.

Statistical analysis
The data obtained from the study was arranged in a tabulated manner in an Excel sheet, and the data was then subjected to statistical analysis such as frequency and percentages.

Ethical considerations
The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

Results
Sociodemographic profile of the study population

The distribution of participants is done according to healthy social practice. 96% of the study participants were breastfed up to the age of 6 months at last and 77% of the study participants were completely immunized up to the age. (Table no.1)

Table no. 1: Distribution of study population according to the socio-demographic profile

Characteristics	Frequency (N=100)	Percentage(%)
AGE IN YEARS		
<1	08	08
1-<5	34	34
5-<10	31	31
10-14	27	27
Total	100	100
SEX		
Male	59	59
Female	41	41
Total	100	100
BIRTH ORDER		
1	12	12
2	27	27
3	33	33
4	17	17
5	10	10
6	01	01
Total	100	100
WEIGHT OF THE CHILD(KG)		
2.6-<8.4	22	22
8.4-<14.8	19	19
14.8-<23.6	29	29
23.6-48	30	30
Total	100	100
SES OF THE FAMILY		
Upper	Nil	Nil
Middle	63	63
Lower	37	37
Total	100	100
RELIGION		
Hinduism	80	80
Islam	20	20
Total	100	100

The majority (34%) of the study participants belong to the age group 1-5 years, followed by the age group 5-10 years which involves 31% of the study participants. 59% of the study participants belong to the Male category and 41% belong to the female category.33% of the study participants have a birth order of 3. 30% of the study participants were of a weight of 23.6 - 48 Kg followed by weight category of 14.8 - 23.6 Kg. 63% of the study participants belong to a middle-income family. 80% of the study participants belong to the Hindu religion and 20% belong to Islam religion. The participants were also distributed as per their social healthy practices. Table no. 2 gives the details of such practice.

Table no.2: Distribution of study population on the basis of social healthy practice

Characteristics	Frequency	Percentage(%)
BREASTFEEDING		
Present	96	96
Absent	04	04
Total	100	100
IMMUNIZATION		
Complete upto the age	77	77
Incomplete upto the age	23	23
Total	100	100

Study participants were distributed based on signs, symptoms, and habits 25% of the study participants habituated with PICA. Among signs, Pallor was the major (98%) sign in the study participants. Icterus was present in only 6% of the study participants. According to the table, Oedema was present in 21% of the study participants. Hepatomegaly was present in 31% of the study participants. Splenomegaly was present in 12% of the study participants. Fever was present in 77% of the study participants. Lymphadenopathy was present in 51% of the study participants. Among participants presenting with bleeding manifestation, the maximum number of participants showed petechial rash which was 6% of all. Bleeding manifestations were absent in 83% of the study participants. Breathlessness on Exertion was present in 57% of the study participants.

Table no.3: Distribution of study population based on signs and symptoms & habits (clinical profile)

Characteristics	Frequency	Percentage(%)
PICA		
Present	25	25
Absent	75	75
Total	100	100
PALLOR		
Present	98	98
Absent	02	02
Total	100	100
ICTERUS		
Present	06	06
Absent	94	94
Total	100	100
OEDEMA		
Generallised	05	05
Pedal	16	16
Absent	79	79
Total	100	100
HEPATOMEGALY		
Not Palpable	69	69
Just Palpable	06	06
Palpable	25	25
Total	100	100
SPLENOMEGALY		
Not Palpable	88	88
Just Palpable	2	2
Palpable	10	10
Total	100	100
FEVER		

Present	77	77
Absent	23	23
Total	100	100
LYMPHADENOPATHY		
Present	51	51
Absent	49	49
Total	100	100
BLEEDING MANIFESTATION		
Black stools	04	04
Black Stools+ Easy Bruising	01	01
Petaechial Rash	06	06
Intracranial Bleeding	01	01
Fresh Blood in Stools	03	03
Haemetemesis	02	02
Absent	83	83
Total	100	100
BREATHLESSNESS ON EXERTION		
Present	57	57
Absent	43	43
Total	100	100

The details of blood transfusion are given in the following table no.4.

Table no. 4: Blood transfusion details

Characteristics	Frequency	Percentage (%)
Present	42	42
Absent	58	58
Total	100	100

Hematological profile of the patients is discussed in table no.5. According to the table, 47% of the study participants having WBC within normal range (4000-11000), 70% of the study participants were having RBC less than normal range (3.86 - 6.5).

According to the table, 46% of the study participants were having Haemoglobin of the range (7 - 10), 99% of the study participants were having HCT value less than normal range (37 - 47), 50% of the study participants were having MCV within the normal range (76 - 96).

According to the table, 69% of the study participants were having MCH less than normal range (27 - 32), 49% of the study participants were having MCHC less than normal range (32- 36), 57% of the study participants were having Platelets within normal range (1.5- 5).

According to the table, 41% of the study participants were having Neutrophil within the normal range (40 - 70), 47% of the study participants were having Lymphocytes within the normal range (20 - 40), 78% of the study participants were having Mixed within the normal range (1 - 20).

Table no. 5: Distribution of study population on the basis of haematological profile CBC

Characteristics	Frequency	Percentage(%)
WBC		
<4000	12	12
4000-11000	47	47
>11000	41	41
Total	100	100
RBC(million/µL)		
<3.86	70	70
3.86-6.5	30	30
Total	100	100
HAEMOGLOBIN(g/dl)		
<5	31	31
5-<7	12	12
7-<10	46	46
10-12.5	11	11
Total	100	100
HCT(%)		
<37	99	99
37-47	01	01
Total	100	100
MCV(fl)		
<76	35	35
76-96	50	50
>96	15	15
Total	100	100
MCH(pg)		
<27	69	69
27-32	22	22
>32	09	09
Total	100	100
MCHC(g/dl)		
<32	49	49
32-36	47	47
>36	04	04
Total	100	100
PLATELETS(lacs/µl)		
<1.5	27	27
1.5-5	57	57
>5	16	16
Total	100	100
NEUTROPHIL(%)		
<40	27	27
40-70	41	41
>70	32	32
Total	100	100
LYMPHOCYTE(%)		
<20	20	20
20-40	47	47
>40	33	33
Total	100	100
MIXED(%)		
<1	08	08
1-20	78	78
>20	14	14
Total	100	100

In the Iron profile, 47% of the study participants had serum ferritin in more than the normal range (22 - 322), and 53% of the participants had TIBC in more than the normal range (262 - 472). 67% of the participants had serum iron less than the normal range (60 -160) and 64% of the participants had TSI less than the normal range (15

- 50). Other relevant parameters - serum, urea, serum creatinine, serum SGPT, serum SGOT, serum folic acid, serum vitamin b12, and serum bilirubin lie within their corresponding normal range. 78% of the study participants had RDW-CV above the normal range (11.5 - 14.5) and Corrected Recti Count within the normal range (0.75 - 2.3). (Table no.6)

Table no.6: Iron profile of the patients

SERUM FERRITIN(µg/l)		
<22	37	37
22-322	16	16
>322	47	47
Total	100	100
SERUM IRON(µg/dl)		
<60	67	67
60-160	20	20
>160	13	13
Total	100	100
TOTAL IRON BINDING CAPACITY(µg/dl)		
<262	07	07
262-472	40	40
>472	53	53
Total	100	100
TRANSFERRIN SATURATION INDEX(%)		
<15	64	64
15-50	27	27
>50	09	09
Total	100	100
OTHER RELEVENT PARAMETERS		
SERUM UREA(mg/dl)		
<13	01	01
13-45	84	84
>45	15	15
Total	100	100
SERUM CREATININE(mg/dl)		
<0.7	08	08
0.7-1.4	84	84
>1.4	08	08
Total	100	100
SERUM GLUTAMIC PYRUVIC TRANSAMINASE(U/L)		
Normal	83	83
High	17	17
Total	100	100
SERUM GLUTAMI OXALOACETIC TRANSAMINASE(U/L)		
Normal	79	79
High	21	21
Total	100	100
SERUM FOLIC ACID		
<2.70	09	09
2.70-17	87	87
>17	04	04
r	100	100

VITAMIN B12		
<239	22	22
239-931	78	78
Total	100	100
TOTAL SERUM BILIRUBIN(mg/dl)		
Normal	96	96
High	04	04
Total	100	100
SERUM BILIRUBIN(DIRECT)		
Normal	95	95
High	05	05
Total	100	100
SERUM BILIRUBIN (INDIRECT)		
Normal	96	96
High	04	04
Total	100	100
RDW-CV		
<11.5	3	3
11.5-14.5	19	19
>14.5	78	78
Total	100	100
CORRECTED RETIC COUNT		
<0.75	17	17
0.75-2.3	78	78
>2.3	5	5
Total	100	100

Discussion
Sociodemographic profile
Age

In the study, the most commonly affected age group was 7-8 years (54.5%).12
A study on a total of 22 pediatric (<18 years) and 20 adult (≥18 years) was conducted. 19% of the study participants belong to the 6-10 yrs age group.13 In a study majority of patients were in the age group of 1-6 years (56.8%).14 A study on children (6 m-18yr) was conducted to know the clinicohematological profile of megaloblastic anemia. The majority (37%) of the participants belong to the age group (10-18 years).15

SEX

In the study, males (63 %) were affected more than females (37%).16 In the study conducted, 29 were male and 13 were female patients, with a ratio of 2.2:1.13 A study in which 58% were males and 42% were females was conducted.17 In the study 58% were males and 42% were female.14In the study conducted, 52% were female and 48% were males.15Similar studies done showed male predominance i.e74.3% and 62.5% respectively.17

Religion

In the study, 80.55% of children were Hindus.10

Social healthy practices

In the study majority of the anaemic children were still breastfeeding (62.9%).18

Birth order

In the study majority of the anaemic children belong to birth order 4. 18

Socioeconomic status

A majority of the families belonged to lower middle grade (73.5%) followed by poor (14.8 %) and upper middle (11.7%) Most of the families had two children (58.7%) followed by one child (34.3%), 5.2%, 1.3 %and 0.4%three four and five respectively in a study.19

Sign & symptoms

The study shows that pallor was present in every child in the study. Icterus is seen in 47.22% of cases in the study.10
Hepatomegaly is seen in 88.89% of cases in the study.8Splenomegaly is seen in 94.44% of cases in the study.10 The results were similar to a study where pallor was present in all the children Hepatomegaly and Splenomegaly in 88.6% and 71.4% of cases and Icterus in 23% of cases. 17
The most common presenting symptom was fever (45%) in the study. 20 Most patients (90%) had significant pallor at the time of admission. Icterus was clinically detected in 35 (51%) children in the study.21

The most frequent complaint was associated with fever. Total children (69.2%) reported fever found in his study conducted at the Institute of Child Health, Madras Medical College, Chennai, Tamil Nadu.4 Fever was a presenting feature in 57% of patients, splenomegaly was found in 30%, and only 2.85% had bleeding manifestations in the study studied the clinicohematological profile and outcome of anemia in children at a tertiary care center at Telangana.22

Clinico hematological profile

Serum ferritin levels were found to be low in only 5 (3.7%) children. High values were seen in 38 (28%) and normal in 93 (68.3%) children. Serum iron levels were measured in 122 cases. It was found to be low in 25 (20.5%) and high in 28 (23%) children. Transferrin saturation was found to be low (< 16%) in 23 (17%) children in the study.23

In this study, in the Iron profile, 47% of the study participants had serum ferritin in more than the normal range (22 - 322), and 53% of the participants had TIBC in more than the normal range (262 - 472). 67% of the participants had serum iron less than the normal range (62 -160) and 64% of the participants had TSI less than the normal range (15 - 50).

In this study, Mean Corpuscular Volume (MCV) was found to be normal in 86 (63.2%), low in 34 (25%), and high in 16 (11.8%) children with severe anemia. Mean Corpuscular Haemoglobin Concentration (MCHC) is found to be low in 127 (93.4%) children. Both MCV and MCHC were low in 34 (25%) children.

In this study, 50% of the study participants were having MCV within the normal range (76 - 96). 69% of the study participants had MCH less than the normal range (27 - 32).49% of the study participants had MCH less than the normal range (32- 36).

A study found that the Mean Corpuscular Volume (MCV) of 42 children (46.1%) was found to be within the range of 80-100 fL. The mean corpuscular Hb of 55 children (60.4%) was within the range of 22 to 25.9 g/dL and the mean corpuscular Hb concentration value of 65 children (71.5%) was in between the range of 27 to 31.9 g/dL.4

The study found a notable correlation between first-digit fingerprint patterns and retinal vascular branching in 200 subjects aged 18 to 30 years. Specifically, 39% of subjects had loop patterns, 36.5% had whorls, and 1.5% had arches on their first digit. Retinal vasculature was more extensive on the temporal side in 87.5% of subjects. Subjects with loops on both thumbs exhibited a higher mean number of branches in the superotemporal quadrant of the left eye, while those with whorls had more branches in the superotemporal quadrant of the right eye. These findings suggest that genetic factors regulating fingerprint patterns may also influence retinal vascular development, highlighting the potential for enhanced biometric identification methods. Further research using advanced biometric tools is recommended to explore these relationships and their underlying genetic mechanisms.

Generalizability

The study's findings suggest a genetic correlation between fingerprint patterns and retinal vascular branching, potentially enhancing biometric identification methods. However, these results are based on a specific demographic (healthy individuals aged 18 to 30) from a single location, necessitating further research across diverse populations and age groups to generalize these findings.

Conclusions

To conclude among 100 pediatric patients studied, Anemia was common in the 1-5 years age group. Children with a male preponderance aplastic anemia were most common among the 10-14 years age group. A most common complaint was pallor and fever. The etiological type was iron deficiency anemia and the morphological type was microcytic hypochromic. Among hemolytic anemias Beta thalassemia major was the only type found. For optimal treatment, multiple facets of anemia need to be addressed.

Limitations

The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of a comparison group also poses a limitation for this study's findings.

Recommendation

In people prone to malnutrition iron supplements or iron-fortified food should be given to children and pregnant women. This approach will prevent the occurrence of iron deficiency. When iron deficiency is not the only cause then the cause should be identified and treated accordingly. The strategies incorporated to prevent anemia should include consideration of etiology and the study of the demography of the population.

Acknowledgment

List of abbreviations

ACD: Anemia of Chronic Disease
CBC: Complete Blood Count
EDTA: Ethylenediaminetetraacetic Acid
G6PD: Glucose-6-Phosphate Dehydrogenase
Hb: Hemoglobin
HCT: Hematocrit
IDA: Iron Deficiency Anemia
MCV: Mean Corpuscular Volume
MCH: Mean Corpuscular Hemoglobin
MCHC: Mean Corpuscular Hemoglobin Concentration
NFHS: National Family Health Survey
OPD: Outpatient Department

PCV: Packed Cell Volume
RBC: Red Blood Cell
RDW: Red Cell Distribution Width
SES: Socioeconomic Status
SGPT: Serum Glutamic Pyruvic Transaminase
SGOT: Serum Glutamic Oxaloacetic Transaminase
TIBC: Total Iron-Binding Capacity
TSI: Transferrin Saturation Index
WBC: White Blood Cell

Source of funding

Conflict of interest
The authors have no competing interests to declare.

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Publisher Details: