The prevalence and associated factors for anaemia in school children in Bengaluru, Karnataka, India: a cross-sectional study

Safder Husain[a], Arish Mohammad Khan Sherwani[b]

[a] MD Unani in Tahaffuzi wa Samaji Tib [Community Medicine (Unani)], National Institute of Unani Medicine (an autonomous organisation under Ministry of AYUSH), affiliated with Rajiv Gandhi University of Health and Science. Bengaluru, India.
[b] Professor and HOD, Tahaffuzi wa Samaji Tib [Community Medicine (Unani)], NIUM (Rajiv Gandhi University of Health and Science), Bengaluru, India.

Abstract

Background and Objective: Anaemia is a common clinical condition that affects the majority of school aged children. Reduced resistance to disease, increased susceptibility to infection, impaired physical development, and poor school performance are all consequences of anaemia in this group. The present study was designed with the objective of estimating the prevalence of anaemia among school children in Bengaluru. This included identifying the associated factors or causes and consequences of anaemia.

Methods: A school based cross-sectional study was conducted among children in schools from 3rd to 8th standard in Bengaluru Urban North Division Karnataka State, India, over a period of one year. 250 children were selected using convenience sampling.

Results: The overall prevalence of anaemia among school going children was found to be 21.2%. Prevalence of anaemia was significant among variables like socioeconomic status, dietary habits, increased heart rate, breathlessness, lack of energy, dizziness, irregular menstrual cycles, jaundice, blood loss during menstruation, menstrual cycle pattern, pallor signs of palpebral conjunctiva, mucous membrane, and skin, splenomegaly and hepatomegaly, consumption of chicken, fish, citrus fruit, milk, *Mizāj ʿĀm* (overall *mizaj* of body, specifically choleric) duration of menstrual flow, headache, poor wound healing, and chronic disease.

Conclusion: The overall prevalence of anaemia in our study of school children in Bengaluru (21.2%) was lower than the prevalence in the data recently shown by NFHS-5. Prevalence of anaemia was highly significant among variables like low socioeconomic status, dietary deficiencies, blood loss, and chronic infections. There were also highly significant correlations with several clinical findings.

Key words: anaemia, prevalence, school children, public health, school health

Introduction

Anaemia is a condition in which the concentration of haemoglobin (Hb) in the blood is lower than the diagnostic reference range.[1] In children, Hb reference ranges differ depending on the child's age and the laboratory that is used in diagnosing the patient.[2]

Table 1. Normal cut–off values for diagnosing Anemia according to The WHO expert groups.[3]

Age Group and Gender	Normal Hb g/dl
Adult males	13
Adult females, non-pregnant	12
Adult females, pregnant	11
Children, 6 months to 6 years	11
Children, 6 to 14 years	12

Anaemia is still common in India, and its prevalence has increased across all age groups by 2–9% among infants, pregnant and non-pregnant women, and men, according to data from the National Family Health Survey 5 (NFHS-5) released on November 24, 2021. Karnataka is one of the worst-performing states, with a significant increase in occurrences of anaemia, having increased from 60.9% (NFHS-4) to 65.5% (NFHS-5).[4] Anaemia has a multiple and complex aetiology and several factors influence anaemia in a population. Nutritional anaemia and non-nutritional anaemia in children are two categories based on the causes.[5] The term "nutritional anaemia" covers all pathological conditions in which the blood haemoglobin concentration falls to a low level due to a deficiency in one or more nutrients. It is the most prevalent form of anaemia in the country. Iron deficiency is considered the most common nutritional deficiency, though other deficiencies can also cause anaemia, including deficiencies of vitamins A, B12, B6, C, D, and E, folate, riboflavin, copper, and zinc. Among these, vitamins A, B6, and B12, folic acid, and riboflavin are required for the normal production of RBCs, while vitamins C and E may protect RBCs through their antioxidant activity. Copper and zinc are trace elements found in the structures of enzymes involved in iron metabolism (e.g., copper and ceruloplasmin).[6]

Anaemia in children can have a variety of non-nutritional causes such as an increased iron requirement during adolescence, hookworm infestation, infections such as malaria or HIV, hemoglobinopathies like thalassemia, and loss of blood in the case of heavy menstrual bleeding.[7]

Some schools in India participate in regular deworming and iron and folic acid supplementation by the school authorities since 2003, as well as mid-day meal programmes including in the selected government schools included in this study.

Methods

The study was conducted in the Department of Tahaffuzi Wa Samaji Tib (Community Medicine/Preventive and Social Medicine), National Institute of Unani Medicine, Bengaluru, India. Ethical approval was obtained from Institutional Ethical Committee (IEC) for Bio Medical researches, NIUM, Bengaluru prior to starting the study. This was a cross-sectional observational and epidemiological study conducted on school children in Bengaluru over a period of one year. A total of 250 students were studied from two government schools in Bengaluru's urban North Division.

Criteria for selection of students

Students were enrolled in the study after fulfilling following selection criteria.

Inclusion criteria

1. School going children of age group of 8 to 14 years.
2. Children in school grades 3–8.

Exclusion criteria

1. Children below 8 and above 14 years-of-age.
2. Children in school below 3rd grade and above 8th grade.

Study design

School based cross-sectional study.

Sample size was based on the prevalence of anaemia taken from a study by Suchitra & Shashikumar (2014), calculated to be 246 by using the formula $N = Z^2 P(1-P)/D^2$ where N= Sample Size, Z= Level of confidence, D= Margin of error, P= Prevalence). By assuming 95% confidence level (Z), margin of error (D) 0.05%, and prevalence (P) was based on a previous study conducted among govt. school children of Bengaluru which was 80%. The sample size was round figured to 250.[8]

Tools for data collection

A questionnaire was designed to collect socio-demographic and personal data, including age, gender, socioeconomic status, and eating habits related to citrus fruit, meat, and green leafy vegetable consumption, systemic examination by the authors related to respiratory system, cardio-vascular system, central nervous system, abdominal examination related to splenomegaly and hepatomegaly, vital examination related to pulse rate, respiration rate, blood pressure, temperature, and *Mizaj*/temperament, clinical manifestation of anaemia and blood and stool examination related to Hb %, and if anaemic on screening the MCV, MCH, MCHC, and stool microscopic tests for ova and cysts. All this information

was recorded in the questionnaire together with a written informed consent form in English or verbally translated into Kannada or Urdu.

Sampling technique

Sampling was done according to the permission granted by school staff and as per COVID-19 protocol. Permission was sought from the block education officers, principals and management of zones of both governments primary and middle schools for the assessments of anaemia and related health issues. After getting approval, we selected samples of school children belong to class 3rd to 8th standards as per the convenience sampling and feasibility of the schools' timetable. We initiated the assessments of both schools until we reached the estimated sample size of 250 children. Criteria for selection of students was strictly followed, that is, inclusion and exclusion criteria.

Measurement of study variables

1. **Socio-demographic variables:** Students were queried about their name, sex, address, religion, types of families, and parents' occupations.

2. **Socio-economic status:** Kuppuswamy modified classification of socio-economic status scale-2020 scale was used. Scores ranged as follows: 26–29 (Upper class I), 16–25 (Upper Middle class II), 11–15 (Lower Middle class III), 5–10 (Upper Lower class IV), and < 5 (Lower class V).

3. **Diet:** History of dietary habits regarding vegetarian and non-vegetarian diet was taken from the children. Questions were asked regarding skipping of meals and frequency of some foods (red meat, chicken, fish, legumes, green leafy vegetables, citrus fruits, whole grains, tea/coffee, and milk).

4. **Past history:**

a) Chronic diseases: Anaemia caused by several chronic diseases such as rheumatoid arthritis, rheumatic fever, SLE, leukaemia, and ankylosing spondylitis.[11]

b) Worm infestation: Intestinal bleeding caused by adult worms with blood in the stool in proportion to the parasite load in the intestine. 1–2 eggs of Ascaris lumbricoides were seen in our study.[12]

5. **Menstrual history:** The pattern of the cycle (regular or irregular), the duration of flow in days (1–3, 4–6, > 7 days), and the amount of blood flow (scanty, moderate, heavy) was estimated by the number of pads used during the periods. The usual amount of blood loss per period is 10 to 35 ml. Each soaked normal sized tampon or pad holds a teaspoon (5ml) of blood. It is considered normal to soak 1 to 7 normal-sized pads or tampons (sanitary products) in a whole period per day. The amount of flow was measured by the number of pads used per day: normal flow (5–7 pads/day), increased/heavy flow (> 7 pads/day), and scanty flow (<1 pad/day).[13]

6. **Clinical Manifestations:** The following signs and symptoms were evaluated among all the subjects.

a) Pallor: Presence on skin, mucous membrane, lower palpebral conjunctiva, tongue, palm, and nails.[14]

b) Splenomegaly: Examined by palpation in the left hypochondriac region. If the spleen was found to be enlarged or a splenic mass moved downwards on inspiration, splenomegaly was suggested.[15]

c) Hepatomegaly: Examined by palpation in the right hypochondriac region.[15]

d) Tachycardia: Defined as a resting heart rate in an adolescent higher than 90 beats per minute.[16]

e) Swollen tongue: Presence of hypertrophic changes in the tongue.[17]

f) Breathlessness/Dyspnoea: Defined as a respiratory rate of more than 40 per minute in children.[15]

g) Lack of energy: Defined as a feeling of being low, tired, lethargic, or fatigued.

h) Dizziness/vertigo: Described a range of sensations, such as fainting, unsteadiness, and weakness. Vertigo was the sensation of the spinning of oneself or one's surroundings.[18]

i) Headache: A painful sensation in any part of the head, ranging from sharp to dull.

j) Jaundice: A yellow discoloration of tissues and body fluids, examined on upper palpebral conjunctiva.[15]

k) Absent or delayed menstruation: Girls who had not reached menarche. Menstruation was considered as delayed if it commenced after 35 days.

l) Irregular menstrual cycle: Irregularities in menstrual cycle, e.g., menorrhagia, metrorrhagia.

m) Blood loss: Acute and chronic blood loss occurring due to any trauma, gastrointestinal tract lesions, or gynaecological disturbances.[17]

7. *Mizaj* (Temperament): This Unani traditional medicine approach based on the four conditions of *Mizaj* which were assessed by observation and self-assessment of 10 parameters including complexion, build, touch, hair, movement, diet, weather, sleep, pulse, emotion known as *Ajnās 'Ashara* mentioned in Table 2 and scored by maximum number of ticks in a particular column of *Mizaj* denoted the dominant temperament or assessed *Mizaj*. Table 2 shows a list of assessment of *Mizaj* (temperament)
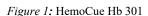
parameters.

Table 2. List of *Mizaj* parameters

PARAMETER	SANGUINE	PHLEGMATIC	BILIOUS	MELANCHOLIC
COMPLEXION	Ruddy (Reddish/ Wheatish Brown)	Chalky (Whitish)	Pale (Yellowish)	Purple (Blackish)
BUILD	Muscular &Broad	Fatty & Broad	Muscular &Thin	Skeleton
TOUCH	Hot & Soft	Cold & Soft	Hot & Dry	Cold & Dry
HAIR	Black & Luster Thick, Rapid Growth	Black & Thin Slow Growth	Brown & Thin Rapid Growth	Brown & Thin Slow Growth
MOVEMENT	Active	Dull	Hyperactive	Less Active
DIET (MOST LIKED)	Cold & Dry	Hot & Dry	Cold & Moist	Hot & Moist
WEATHER (MOST SUITABLE)	Spring	Summer	Winter	Autumn
SLEEP	Normal (6-8 hour)	In excess	Inadequate	Insomnia
PULSE	Normal in Rate(70-80/min)	Slow in Rate(60-70min)	Rapid in Rate (80-100/min)	Slow in Rate (60-70/min)
	Large in Volume	Normal in Volume	Normal in Volume	Less in Volume
EMOTIONS	Normal	Calm & Quiet	Angry	Nervous

Method of collection of blood

After the questionnaire and physical exam were completed and recorded, blood was collected from children and tested for anaemia using the HemoCue (Hb 301) analyser within 10–20 sec at the school. Participants were classified as having mild (10-11.9 g/dl), moderate (7-9.9 g/dl), and severe (≤7.0 g/dl) anaemia based on WHO grading of anaemia.[7] Following the blood collection, experienced nurses and lab personnel collected the samples and tested children, adolescent girls and boys. Samples were collected into microcuvettes and the filled cuvettes for the assessment of Hb%; on the spot collected blood samples were analysed by using a HemoCue (HB 301) analyser only. The Hb value was immediately displayed on the screen of the analyser and was recorded in proforma.[9]

Note: A drop of whole blood was introduced into a plastic cuvette by capillary action. The cuvette was placed in the machine, which produces a direct read-out of haemoglobin to one decimal place. The procedure is depicted in the figure 1 HemoCue Hb 301.[10]

Statistical Methods

Each completed questionnaire was manually checked for completeness and consistency before it was tabulated in Microsoft Excel 2019. SPSS version 16.0, Vassar Stat, and SISA statistical software were used for the analysis of the data. Results of categorical measurements are presented in frequencies (numbers) and percentages. Significance was assessed at a .05% level. The Chi-Square/Fisher's exact test was used to find the significance of study parameters on a

Figure 1: HemoCue Hb 301

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categorical scale between two or more groups. Microsoft Word and Excel were used to generate tables and graphs.[19]

Ethics and CTRI procedure

The study was started following approval of the study protocol by the Institutional Ethical Committee, NIUM, Bengaluru, vide IEC No: NIUM/IEC/2019-20/036/TST/07 and Registration No: 07_U006_105670. The study was entitled "Study of Prevalence of *Faqr Al-Dam* (Anaemia) Among School Going Children." It has been successfully registered in the Clinical Trials Registry-India (ICMR-NIMS) before the study. The Trial Acknowledgement Number is REF/2021/01/040240.

Results

Table 3 shows the prevalence of anaemia to be 21.2%. Mild anaemia accounted for 16.8%, moderate anaemia accounted for 4%, and severe anaemia accounted for just 0.4%.

Table 3. Prevalence of anaemia among subjects

Grade of Anaemia	No. of students	%

Children without anaemia (Hb ≥12 gm/dL)	197	78.8
Children with anaemia (Hb ≤12 gm/dL)		
Mild Anaemia (10-11.9 g/dl)	42	16.8
Moderate Anaemia (7-9.9 g/dl)	10	4
Severe Anaemia (≤7.0 g/dl)	1	0.4
Total	250	100

Table 4 shows that the majority of the 53 anaemic children studied had hypochromic and normocytic (normal cell) anaemia 52.8%, hypochromic and microcytic anaemia 45.3%, and hypochromic and macrocytic (megaloblastic) anaemia only 1.9%.

Table 4. Distribution of Anaemia according to cell morphology

Cell morphology on peripheral smear exam	No of Anaemic Children	%
Hypochromic and Normocytic	28	52.8
Hypochromic and Microcytic	24	45.3
Hypochromic and Macrocytic	1	1.9
Total	53	100

Table 5 shows the list of different variables are used in the study and also mentioned in the questionnaire.

Table 5. List of Different Variables

Variables	Anaemic (n=53)	Non-Anaemic (n=197)	Total (n=250)	P. value
Kuppuswamy socio economic scale-2020				
Upper Middle	2 (12.5%)	14 (87.5%)	16 (100%)	<.0001**
Lower middle	8 (11.9%)	59 (88.1%)	67 (100%)	
Upper lower	27 (18.8%)	117 (81.2%)	144 (100%)	
lower class	16 (69.6%)	7 (30.4%)	23 (100%)	
Dietary habits				
Vegetarian	37 (44%)	47 (56%)	84 (100%)	<.0001**
Mixed	16 (9.6%)	150 (90.4%)	166 (100%)	
Clinical presentation				
Increased heart rate				
Present	12 (80%)	3 (20%)	15 (100%)	<.0001**
Absent	41 (17.4%)	194 (82.6%)	235 (100%)	
Breathlessness, or trouble catching a breath				
Present	17 (94.4%)	1 (5.6%)	18 (100%)	<.0001**
Absent	36 (15.5%)	196 (84.5%)	232 (100%)	
Lack of energy, or tiring easily				
Present	49 (62.8%)	29 (37.2%)	78 (100%)	<.0001**
Absent	4 (2.3%)	168 (97.7%)	172 (100%)	
Dizziness, or vertigo, especially when standing				
Present	33 (78.6%)	9 (21.4%)	42 (100%)	<.0001**
Absent	20 (9.6%)	188 (90.4%)	208 (100%)	
Headache				
Present	25 (31.2%)	55 (68.8%)	80 (100%)	0.0077**
Absent	28 (16.5%)	142 (83.5%)	170 (100%)	
Absent or delayed Menstruation (in total Female students, N=131)				
Present	2 (50%)	2 (50%)	4 (100%)	0.237
Absent	29 (22.8%)	98 (77.2%)	127 (100%)	

Irregular Menstrual cycles (in Total Female students, N=131)

Present	12 (75%)	4 (25%)	16 (100%)	<.0001**
Absent	19 (16.5%)	96 (83.5%)	115 (100%)	

Sore or swollen tongue

Present	32 (100%)	0 (0%)	32 (100%)	<.0001**
Absent	21 (9.6%)	197 (90.4%)	218 (100%)	

Jaundice, or yellowing of skin, eyes, and mouth

Present	48 (78.7%)	13 (21.3%)	61 (100%)	<.0001**
Absent	5 (2.6%)	184 (97.4%)	189 (100%)	

Slow or delayed growth and development

Present	32 (82%)	7 (18%)	39 (100%)	<.0001**
Absent	21 (9.95%)	190 (90.05%)	211 (100%)	

Poor wound and tissue healing

Present	4 (80%)	1 (20%)	5 (100%)	0.008**
Absent	49 (20%)	196 (80%)	245 (100%)	

Pallor Palpebral conjunctiva

Present	48 (56.5%)	37 (43.5%)	85 (100%)	<.0001**
Absent	5 (3%)	160 (97%)	165 (100%)	

Pallor Mucous membrane of mouth

Present	30 (62.5%)	18 (37.5)	48 (100%)	<.0001**
Absent	23 (11.4%)	179 (88.6%)	202 (100%)	

Pallor Skin

Present	46 (85.2%)	8 (14.8%)	54 (100%)	<.0001**
Absent	7 (3.6%)	189 (96.4%)	196 (100%)	

Splenomegaly

Present	17 (100%)	0 (0%)	17 (100%)	<.0001**
Absent	36 (15.5%)	197 (84.5%)	233 (100%)	

Hepatomegaly

Present	20 (100%)	0 (0%)	20 (100%)	<.0001**
Absent	33 (14.3%)	197 (85.7%)	230 (100%)	

Chronic Diseases
Blood loss

Present	11 (100%)	0 (0%)	11 (100%)	<.0001**
Absent	42 (17.6%)	197 (82.4%)	239(100%)	

Worm Infestation

Present	2 (100%)	0 (0%)	2 (100%)	0.044
Absent	51 (20.6%)	197 (79.4%)	248 (100%)	

Chronic Infection

Present	4 (80%)	1 (20%)	5 (100%)	0.008**
Absent	49 (20%)	196 (80%)	245 (100%)	

Dietary Intake (Frequency times/ week)
Chicken

1-2 T/W	16 (10.4%)	138 (89.6%)	154 (100%)	<.0001**
3 T/W	1 (6.3%)	15 (93.7%)	16 (100%)	
Never	36 (45%)	44 (55%)	80 (100%)	

Fish

1-2 T/W	5 (4%)	119 (96%)	124 (100%)	<.0001**
3 T/W	0 (0%)	2 (100%)	2 (100%)	
Daily	0 (0%)	1 (100%)	1 (100%)	
Never	48 (39%)	75 (61%)	123 (100%)	

Green leafy vegetables

1-2 T/W	0 (0%)	13 (100%)	13 (100%)	< 0.05
3 T/W	15 (25.4%)	44 (74.6%)	59 (100%)	
4-6 T/W	26 (26%)	74 (74%)	100 (100%)	
Daily	12 (15.4%)	66 (84.6%)	78 (100%)	

Citrus Fruits (Oranges)

1-2 T/W	27 (18.9%)	116 (81.1%)	143 (100%)	<.0001**
3 T/W	2 (15.4%)	11 (84.6%)	13 (100%)	
4-6 T/W	2 (16.7%)	10 (83.3%)	12 (100%)	
Daily	7 (10.9%)	57 (89.1%)	64 (100%)	

Never	15 (83.3%)	3 (16.7%)	18 (100%)	
Whole grains				
1-2 T/W	2 (22.2%)	7 (77.8%)	9 (100%)	0.427
3 T/W	2 (28.6%)	5 (71.4%)	7 (100%)	
4-6 T/W	13 (29.5%)	34 (70.5%)	47 (100%)	
Daily	36 (20.1%)	143 (79.9%)	179 (100%)	
Never	0 (0%)	8 (100%)	8 (100%)	
Milk				
1-2 T/W	17 (58.6%)	12 (41.4%)	29 (100%)	<.0001**
3 T/W	4 (40%)	6 (60%)	10 (100%)	
4-6 T/W	0 (0%)	6 (100%)	6 (100%)	
Daily	17 (10.1%)	152 (89.9%)	169 (100%)	
Never	15 (41.7%)	21 (58.3%)	36 (100%)	
Mizaj e Aam				
Damvi (Sanguinic)	3 (2.0%)	145 (98%)	148 (100%)	<.0001**
Balghami (Phlegmatic)	1 (2.4%)	41 (97.6%)	42 (100%)	
Safravi (Choleric)	48 (87.3%)	7 (12.7%)	55 (100%)	
Saudavi (Melencholic)	1 (20%)	4 (80%)	5 (100%)	
Menstrual History (Female students)				
Menstrual Cycle				
Regular	17 (19.5%)	70 (80.5%)	87 (100%)	<.0001**
Absent	4 (12.9%)	27 (87.1%)	31 (100%)	
Irregular	10 (76.9%)	3 (23.1%)	13 (100%)	
Total	31 (23.7%)	100 (76.3)	131 (100%)	
Duration of Flow				
1 to 3 days	8 (20.5%)	31 (79.5%)	39 (100%)	0.006**
3 to 5 days	9 (20.5%)	35 (79.5%)	44 (100%)	
5 to 7 days	10 (58.8%)	7 (41.2%)	17 (100%)	
Absent	4 (12.9%)	27 (87.1%)	31 (100%)	
Total	31 (23.7%)	100 (76.3)	131 (100%)	
Amount of blood flow				
Normal Flow	17 (19.5%)	70 (80.5%)	87 (100%)	<.0001**
Increased	10 (76.9%)	3 (23.1%)	13 (100%)	
Absent	4 (12.9%)	27 (87.1%)	31 (100%)	
Total	31 (23.7%)	100 (76.3)	131 (100%)	

Discussion

In the present study, we have used various established variables of anaemia and found the level of significance of the association among them. These variables have been described separately in ancient Unani literature and modern scientific research as well, either as causes or consequences of childhood anaemia. We have observed the association with anaemia in variables like socioeconomic status, diet, clinical presentation, chronic infection, signs of pallor, dietary intake, *Mizaj e Aam*, and menstrual history.

The total prevalence of anaemia was 21.2% of children in this study. The prevalence according to severity was as follows: the majority (79.2%) had mild grade anaemia, moderate anaemia prevalence was 18.9%, and severe anaemia was only 1.9%. The anaemia prevalence in our study was similar to that of Kumar T *et al;*[20] the WHO research studied children worldwide, where the prevalence was 39.8%.[21] The reason for our lower prevalence could be

regular deworming and iron and folic acid supplementation by the school authorities in Bangalore since 2003.[20,21]

The present study revealed that the prevalence of anaemia varies among different socio-economic classes with the correlation being significant (P<.0001). Anaemia was more prevalent among V (lower class). This may be due to low literacy status and poor nutrition as found in a study by Kavthekar S *et al.* [22] Anaemia and dietary habits were significantly correlated (P<.0001) and the majority were vegetarians. This was due to poor bioavailability of dietary iron coupled with a low intake of haem iron derived from animal food and a low intake of green leafy vegetables and dairy products. Major components of the diet in developing countries like India are cereals and roots, which are not favourable for iron absorption as compared to meat and fish. The frequency and amount of consumption of non-vegetarian food among the studied population was quite low as a greater number of lower

socioeconomic status children were included in our study, consistent with a study by Ayushi Agrawal *et al.*[23]

The present study observed the following clinical presentations of anaemia which included swollen tongue, enlarged spleen or liver, increased heart rate, breathlessness, vertigo, irregular menstrual cycle, and delayed growth (P<.0001). Headache (P=0.007) and poor wound healing (P=0.008) were significantly associated with anaemia. This reflected the fact that anaemia is often asymptomatic, and has non-specific signs and symptoms unless the anaemia is severe.

On statistical analysis, occurrence of anaemia was found to be significant for blood loss (P<.0001), worm infestation (P=0.044), and chronic infections (P=0.008), respectively. Tiwary *et al*. observed in a similar study that hook worm associated anaemia in children was higher by 23.57%. This may be due to poor hygienic practices, poor educational background, poor sanitation, unsafe drinking water, use of contaminated food, and lack of health awareness.[24]

Statistical analysis revealed a significant relationship between anaemia and irregular menstrual cycles (P<.0001). Blood losses associated with menstruation are a common cause of iron deficiency. Typically, non-menstruating women lose about 1 mg of iron per day, while menstruating women lose an additional 10 mg of iron per day during menses. When combined with greater and heavier blood loss during menstruation, even a regular menstrual cycle can cause anaemia, as found in the present study. Statistical analysis revealed a significant relationship (P=0.006) with anaemia. Menstrual cycle pattern was also significantly associated (P<.0001) with anaemia because it represents greater blood loss on average during one menstrual cycle. Heavy menstrual bleeding is a common cause of iron deficiency and iron deficiency anaemia in women of reproductive age. [25]

Statistical analysis revealed a significant relation between anaemia and pallor signs (P<.0001). Our study was closely related to the study of Keshav K *et al*., which also found a significant difference (P<0.001) between anaemia and a pallor signs.[26]

Our study showed that splenomegaly and hepatomegaly have a significant relationship with anaemia (P<.0001). There was no known research on the relationship between anaemia and hepatosplenomegaly. However, our findings are possibly due to red blood cell sequestration in the spleen that lowers the effective circulating mass of red blood cells.[27] We found a significant

relationship between anaemia and reduced chicken consumption (P<.0001). This significant relationship is consistent with the study conducted by Divyamol N *et al.,* which showed that low consumption of chicken was associated with anemia.[28] We also found low fish consumption to have a significant relationship to anaemia (P<.0001). Fish is a good source of iron because it is bioavailable.[3] Anaemia was shown to be less present among those who consumed green leafy vegetables (P<0.05). These data support the importance of these foods in terms of nutrition. Green leaves are high in carotenes, calcium, iron, and vitamin C, with the exclusion of vitamin B12 (an iron absorption promoter).[3] Anaemia and citrus fruit eating were found to have a statistically significant connection (P<.0001) across all consumption groups, with the highest number of affected subjects. The probable explanation for this finding may be that citrus is an excellent source of vitamin C. Most people can achieve 100% of the RDA for vitamin C by consuming moderate amounts of citrus fruit. Asians consume approximately 71 gm per capita per day. Vitamin C (ascorbic acid) is a water-soluble essential nutrient that acts as an antioxidant and is involved in iron metabolism as an iron absorption promoter. [3] Increased occurrences of anaemia in those group may be due to some other factors like reduced B12 in leafy vegetable, socioeconomic reasons, etc. The prevalence of anaemia was found to have a statistically significant connection with reduced milk consumption (P<.0001). Our findings are similar with that of El Menchawy I *et al*. who found a significant effect (P=0.037) in Moroccan school children. The results showed that milk drinking reduced iron deficiency from 50.9% to 37.2% of dietary iron absorption.[29] There was a significant correlation between anaemia and *Mizaj* according to statistical analysis (P<.0001). This significantly high occurrence of Choleric *Mizaj* among anaemic school going children was in accordance with the Unani concept, which states that *Sanguinic Mizaj* was related to the higher production of *khilt Dum* (Blood) in comparison to other *Mizaj* groups. This sequence of blood production decreases with Phlegmatic *Mizaj* as phlegm is considered as immature or unripped blood (*kachcha khoon)* that leads to formation of mature RBC or blood if there is no dietary deficiency. Choleric and Melancholic temperaments have more disintegration of blood or RBC to yellow bile (Bilirubin, Biliverdin) and black bile (people with benign lesion, moles or cancerous lesion), respectively. [30,31]

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In Unani system of medicine all human beings have distinguished *mizaj* which is classified into four qualitative categories: 1. *Damvi* (sanguineous), 2. *Safravi* (bilious), 3. *Balghami* (phlegmatic), and 4. *Saudavi* (melancholic). This classification is based on four humoral theories in which every person has a holistic *Mizaj* as a whole and every organ of the body has also its unique *Mizaj* that varies from person to person. In the Unani System of Medicine, *Mizaj* (Temperament) acts as a basis for diagnosis and treatment. The evaluation and classification of temperaments is based on the intermixture of four *akhlat* (humours) in varying quantities in the blood, so blood plays a key role in the constitution of *Mizaj*. Domination of humours, such as blood, phlegm, bile, and black bile in the blood classifies people as sanguine, phlegmatic, choleric, or melancholic.[32]

According to the Unani physicians Ibn Sina, Ismail Jurjani, Ibn Hubal Baghdadi, and Hakim Azam Khan blood is considered to be the vital fluid of human body which is formed in the liver. Due to derangement of the liver functions and weakness of hepatic faculties, or sometimes due to associated disease, the resultant formation of blood in normal for nourishment there by leading to anaemia. [33,34] Razi (Razes, 841-926AD) and Abul Hasan Ahmad Bin Mohammad Tabri (10th century AD) have mentioned that *sū mizāj kabid bārid wa rātāb* (deranged cold and wet temperament of liver), leads to the development of features of iron deficiency anaemia, which they have described as *Sū'al-Qinya*.[35] The word *Sū'al-Qinya* was coined by Ismail Jurjani (12th C AD). *Sū* means defect and *Qinya* means treasure, therefore anaemia might be considered a treasury defect.[36]

According to Unani medicine, various synonyms (20th century term: *Faqr al-Dam,* Century-old terms: *Sū'al-Qinya*, *Qillat-i-dam*, *khoon-ki-Kami, khoon ki mohtaji (ghareebi,nadari)* and *Faṣad al-Dam.*[37]) for anaemia were used.

Faqr al-Dam is a word in Arabic that means "blood shortage or loss." The Arabic word "*Sū 'al-Qinya*" refers to a storage change or deficiency, which is linked to the iron or dietary deficiency anaemia. Some Unani physicians refer to *Sū'al-Qinya* as "*Ḍu'f al-jigar*" (weakness of the liver due to impaired metabolism of liver), while others refer to it as "*Sū'-i- Mizāj*" (an imbalance of individual's temperament). Others have called it *"Ridhayat-e-dam"* which refers to changes in blood quality or morphology (like hyper chromic, hypochromic, and size of cells), and concentration, odour, viscosity, temperature, and colour as well.[38]

Limitations of the study

1. The study used a school health survey when schools were opened for a limited period in Karnataka. The school management and principals were not fully cooperative to allow the investigators to conduct the study and to obtain blood and other investigations. So convenient sampling technique was used over a year's time.
2. Anaemia diagnosis was based on Hb% and cell indices, and aetiologies were not further confirmed by serum ferritin or other tests due to lack of facilities and resources.
3. The study was conducted only in urban areas.

Conclusion

The overall prevalence of anaemia in our study of government school children in Bengaluru (21.2%) was lower than the prevalence in the data recently shown by NFHS-5.

Prevalence of anaemia was highly significant among variables like low socioeconomic status, dietary deficiencies (low consumption of chicken, fish, citrus fruit, and milk), heavy blood loss during menstruation, and irregular menstrual cycle patterns, and chronic infections. There were also highly significant correlations with clinical findings of increased heart rate, breathlessness, lack of energy, dizziness or vertigo, sore or swollen tongue, jaundice, enlarged spleen or liver, delayed growth, headache, poor wound healing, and pallor of palpebral conjunctiva, mucous membrane, and skin. *Mizāj 'Ām* correlated significantly with the *Safravi* (Choleric) temperament.

Anaemia is still a major burden in children of India, even in areas with school-based interventions, so this suggests further longitudinal studies are needed to asses school-based or community interventions.

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Appendix

NATIONAL INSTITUTE OF UNANI MEDICINE
kottigepalya, Magadi main road, bengaluru
(Affiliated to Rajiv Gandhi University of Health and Science Jayanagar Bengaluru)

"Study of prevalence of Faqr al-Dam (anaemia) among school going children"

RESEARCH QUESTIONNAIRE/SCHEDULE/PERFORMA

Segment A: Socio-Demographic Data   **Date__/__/__**

Name of Student _____

Age: _____ year old

Gender: Male _____   Female _____   Other_____

Standard/Grade: (iii) ___ (iv)_____ (v)___ (vi)___ (vii)____ (viii)____

Habitation: Rural ( )   Urban ( )

Type of Family: Nuclear ( )   Joint ( )

Religion: Hindu ( ) Muslim ( ) Christian ( ) Other ( )

Types of School: Government ( ) Private ( )

Father's / Guardian Name: _____

Address: _____

Contact no: _____

Name of the School with Address: _____

Socio-economic status: I (Upper Class), II (Upper Middle Class), III (Lower Middle Class), IV (Upper Lower Class), V (Lower Class),

Segment B: Assessment of Anaemia through following parameters:

Clinical presentation:

➢ Increased heart rate	Present	Absent
➢ Breathlessness, or trouble catching a breath	Present	Absent
➢ Lack of energy, or tiring easily	Present	Absent
➢ Dizziness, or vertigo, especially when standing	Present	Absent
➢ Headache	Present	Absent
➢ Irritability	Present	Absent
➢ Irregular menstrual cycles	Present	Absent
➢ Absent or delayed menstruation	Present	Absent
➢ Sore or swollen tongue	Present	Absent
➢ Jaundice, or yellowing of skin, eyes, and mouth	Present	Absent
➢ Enlarged spleen or liver	Present	Absent
➢ Slow or delayed growth and development	Present	Absent
➢ Poor wound and tissue healing	Present	Absent

H/O Present Illness: _____
Past history:

- Blood loss
  - o GIT   Present   Absent
  - o Non-GIT   Present   Absent
- Worm Infestation   Present   Absent
- Chronic Infection   Present   Absent
- Blood disorders   Present   Absent
- Blood transfusion   Present   Absent
- Surgical intervention   Present   Absent

Family history:
- Blood disorder: Present   Absent
- Iron deficiency anaemia   Present   Absent

Personal habits:
- Appetite: Good   Fair   Poor
- Diet: Veg   Non-Veg   Mixed
- Sleep: Sound   Disturbed
- Bowel habit: Regular   Irregular
- Bladder habit: Regular   Irregular
- Physical work: Sedentary   Mild   Moderate   Hard work

Menstrual history:
- Age of menarche**:** _____
- Menstrual cycle: Regular   Irregular
- Duration of cycle: <25   25-28   30-35   35-45   >45
- Duration of flow: 1-3   3-5   5-7   >7
- Amount of blood flow: Normal flow   Increased flow   Scanty
- LMP: _____

General Physical Examination:
- General condition: Healthy   Unhealthy
- Nutritional status: Poor   Average
- Icterus: Present   Absent
- Cyanosis: Present   Absent
- Clubbing of fingers: Present   Absent
- Oedema: local/general   Present   Absent
- Palpable lymph node: Present   Absent
- Pallor: Present   Absent
  - o Palpebral conjunctiva   Present   Absent
  - o Mucous membrane   Present   Absent
  - o Skin   Present   Absent
  - o Palmer creases   Present   Absent

Vital Data:
- Pulse rate: _____ /minute
- R.R: _____ /minute
- B.P: _____ /mmHg
- Temperature: _____^{0}F
- Temperament of the students: Damvi (), Balghami (), Safravi(), Saudavi()

Systemic examination
- RS: _____

- CVS: _____
- CNS: _____

Abdominal Examination:

- Splenomegaly   Present   Absent
- Hepatomegaly   Present   Absent

INVESTIGATION:

Hb(gm%) If Anaemic:	
MCV	
MCHC	
MCH	
Stool routine and microscopic Test (for Ova & Cysts)	

DIETARY HABITS:

Breakfast _____

Lunch _____

Dinner _____

How often do you eat or drink the following?

Items	Daily	4-6 times/week	3 times /week	1-2 times/week	never
Red meat (Beef; Lamb)					
Chicken					
Fish					
Legumes					
Green leafy Vegetables					
Citrus Fruits(oranges)					
Whole grains					
Tea / coffee					
Milk					

Segment C: Assessment of *Mizaj e Aam*

PARAMETER	SANGUINE	PHLEGMATIC	BILIOUS	MELANCHOLIC
COMPLEXION	Ruddy (Reddish/ Wheatish Brown)	Chalky (Whitish)	Pale (Yellowish)	Purple (Blackish)
BUILT	Muscular &Broad	Fatty & Broad	Muscular &Thin	Skeleton
TOUCH	Hot & Soft	Cold & Soft	Hot & Dry	Cold & Dry
HAIR	Black & Luster Thick, Rapid Growth	Black & Thin Slow Growth	Brown & Thin Rapid Growth	Brown & Thin Slow Growth
MOVEMENT	Active	Dull	Hyperactive	Less Active
DIET (MOST LIKED)	Cold & Dry	Hot & Dry	Cold & Moist	Hot & Moist
WEATHER (MOST SUITABLE)	Spring	Summer	Winter	Autumn
SLEEP	Normal (6-8 hour)	In excess	Inadequate	Insomnia
PULSE	Normal in Rate(70-80/min) Large in Volume	Slow in Rate(60-70min) Normal in Volume	Rapid in Rate (80-100/min) Normal in Volume	Slow in Rate (60-70/min) Less in Volume
EMOTIONS	Normal	Calm & Quiet	Angry	Nervous

(Maximum no. of ticks in a particular column denote the dominant temperament)

1. Sanguine………….

 2. Phlegmatic………

3. Bilious…………...

4. Melancholic………