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Enormity of iron deficiency anaemia and haematological indices in Primary and secondary school going children in central rural Gujarat, India

Research Article

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Abstract

Anemia is one of the associated and underlying health conditions observed in large number of school going children of rural India. National Family Health Survey (NHFS) data published by Government of India indicates increased prevalence of anaemia in children of rural India. In the present study, children of government school of the Waghodia tehsil, Vadodara district Gujarat were surveyed. A cross sectional study was conducted to survey 500 children of either gender according to WHO gradation as normal range (12.6 ± 0.54 gm/dl); mild anemia (11.01 ± 0.58gm/dl) and moderate anemia(9.11 ± 0.3gm/dl).Observations indicated that, 20.6%, 74.8% and 4.6%children were in normal or above normal range, mild anemia and moderate anemia respectively. Overall79.4% of children have anemia. It reveals the escalating magnitude of prevalence of IDA in rural Gujarat. Prevalence is more in 9-11 age group (56%). Gender wise distribution shows mild and moderate anemia in 305 (80.9%) and 14 (3.7%) respectively amongst 377 male children; whereas mild anemia and moderate anemia in 305 (80.9%) and 14 (3.7%) respectively amongst 123 female children. In nutshell, prevalence of anemia is prominent in children of age group in different rural parts of Gujarat.

Key Words: Anemia, Survey study, School going children, Gujarat, Limda.

Introduction

The nutritional status is a crucial factor which defines health and well being of a child. Nutritional deficiency anemia is a major public health problem in children and pregnant women especially in developing countries including India. Anaemia is never a defined disease, however an indication of underlying pathological process or disease of various aetiologies like worm infestations, malnutrition etc. As a consequence of these various factor iron deficiency determines prime nutritional deficiency health problem.

The magnitude of the problem is high among both urban and rural populations. As the fact mild to moderate forms of anemia are not detected by the parents and it goes unnoticed and untreated until clinician or pediatrician identifies the condition when the child is brought to him for any other health problem. Rural parents or the lower socioeconomic population does not take their children for routine health checkups, even if these children are taken for the routine immunization clinical examination missed out.

Anemia is a condition that is marked by low level of hemoglobin in the blood. Iron is a main component of hemoglobin and iron deficiency is estimated to be responsible for half of all anemia globally (3 NFHS-4 2015-16 P -298)(1).As per NHFS survey 2015-16 children in the age group of 6-59 months, 59% of children had some degree of anemia (hemoglobin levels below 11.0 g/dl), 28% had mild anemia(2).The trend of anemia in year 2005-2006 had reduced from 70% to 59% but continued at higher side among rural children. In Gujarat prevalence of any anemia in children of age 6 to 59 months was 62.6%, (NHFS 2015-16 P 322 TABLE 10.13)(3). Anemia in young children can result into impaired cognitive abilities language development motor and behavioral development and increased risk of morbidity from infectious diseases.

So the early detection through screening and surveillance, preventive measures and timely management of IDA in children is very essential to ensure wellbeing of all age group children. Different cross-sectional survey studies found the base in such mass screening program.

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Cross-sectional studies (also known as Cross-sectional analysis) form a class of research methods that involve observation of all of a population, or a representative subset, at a defined time. They differ from case-control studies in that they aim to provide data on the entire population under study.

These studies described certain feature of the population, such as prevalence of an illness, or they may support inferences of cause and effect. In addition, cross-sectional studies involve data collected at a defined time. They are often assessed the prevalence of acute or chronic conditions, or to answer questions about the causes of disease or the results of medical intervention. Cross-sectional studies may involve special data collection, including questions about the past, but they often rely on data originally collected for other purposes. The use of routinely-collected data allows large cross-sectional studies to be made at little or no expense. This is a major advantage over other forms of epidemiological study.

Hence the present survey study has been designed to know the prevalence of anemia in school going children of Waghodia village (GJ) as a preliminary part of clinical study for doctoral research work.

Methodology

Cross sectional study: Total 500 children from the rural area of Waghodia village from primary-secondary health school were surveyed. Present survey conducted in between February 2020 to March 2020.

Method of Collection of Data

Study Design

A Cross sectional study was carried during February 2020 to March 2020, involving 500 children of either sex of two government schools of Waghodia village, rural area in Vadodara district, Gujarat; after obtaining consent from parents and head of the school.

Sample Size

Sample size was calculated using the formula {(1.96)2×P×(1-P)}/(0.05)considering the prevalence of anaemia as 50%, and 95% confidence interval, the target sample size was 384. Considering non-response rate as 20%, the sample size was 461; more than required number was taken to minimize the permissible errors, and hence round up 500 children were screened.

Ethical Approval

Institutional ethical approval was obtained for the study, consent from parent of each child and school authority was obtained in prescribed format which was also approved by ethical committee.

Collection of Data

A specially designed Survey study case record form was prepared and validated through authorities was used to obtain relevant demographic and socioeconomic data. Age of each child was collected from date of birth enrolled in school register provided by the school authorities.A survey proforma was filled after obtaining required data from the parents of children below 10 years of age to ensure the accuracy of data.

Blood Sample Collection

Peripheral blood was collected (5 ml), under aseptic precautions in tubes containing ethylene diamine tetra acetic acid (EDTA) at a final concentration of 1 mg/ml. Blood cells were counted at the Institutional hospital laboratory using semi automated analyzer 3-Part Medonic M20 (Differential Cell Counter - 3-Part: Medonic M16/M20 - Sweden). The blood was well mixed and placed on a rack in the analyser.The instrument counted the number and type of different cells within the blood and the results of haemoglobin (Hb), red blood cell (RBC), and hematocrit (HCT), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC), white blood cell (WBC), granulocyte, lymphocyte, and monocytes were noted. Adequate quality control measures were taken in each test procedure to ensure the reliability of the results.

Children having Hb< 11.5gm/dl are considered as anaemic and graded as mild anaemia Hb 11 – 11.4gm/dl, moderate anaemia 8 – 10.9gm/ dl and severe anaemia Hb< 8gm/dl as per WHO guidelines ()

A team of 4 consultants and Post graduates scholars of *Kaumarabhritya* (Paediatric) department conducted the clinical examination of the school children to assess the health status including the anthropometry.

Statistical Analysis: Anemia was defined as Hb concentration <11 g/dL for children aged between 6 and 59 months while <11.5 g/dL for children aged between 5 and 11 years and<12 g/dL for children aged 12 years according to WHO. Further, Normal reference ranges used for hematological indicators (red blood indices and white blood indices) are provided in Table 2 [10, 11]. Data obtained were recorded in Microsoft Excel 2007 and all statistical analyses were performed with GraphPad Prism software (version4.00). SPSS for Windows version 17.0, Chicago, USA, was also used for data analysis. Descriptive characteristics (mean and standard deviation) and percentage were performed for each parameter separately. Chi-square and independent*t*-test were used for proportions and mean comparisons between groups, respectively. Pearson's correlation tests were performed to examine the relationships between haematological indicators. The strength of association is measured by unadjusted odds ratio (OR) and 95%confidence interval (CI).

Observations and Results

Table No.1: Comparison of degree of Anemia with different religion and gender in different age group

Age group of children	Gender	Frequency	Percent	Religion	Frequency	Percent	Anemia	Frequency	Percent
6 to 8 years	Male	54	79.4	Hindu	54	79.4	Normal	13	19.1
	Female	14	20.6	Muslim	14	20.6	Mild	49	72.1
	Total	68	100.0	Total	68	100.0	Moderate	6	8.8
							Total	68	100.0
9 to 11 years	Male	266	70.9	Hindu	311	82.9	Normal	79	21.1
	Female	109	29.1	Muslim	64	17.1	Mild	280	74.7
	Total	375	100.0	Total	375	100.0	Moderate	16	4.3
							Total	375	100.0
12 to 14 years	Male	57	100.0	Hindu	49	86.0	Normal	11	19.3
	Female	0	0	Muslim	8	14.0	Mild	45	78.9
	Total	57	100.0	Total	57	100.0	Moderate	1	1.8
							Total	57	100.0

Table No. 2: Comparison of Hematological Indices in different age groups

Age group of children		N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
6 to 8 years	PCV	68	35.6765	2.17153	0.26334	135.478	67	0.000
	MCV	68	69.2618	4.31461	0.52322	132.375	67	0.000
	MCH	68	21.3735	1.20529	0.14616	146.231	67	0.000
	MCHC	68	23.0559	2.03465	0.24674	93.443	67	0.000
9 to 11 years	PCV	375	36.0373	2.37726	0.12276	293.556	374	0.000
	MCV	375	68.8296	4.41037	0.22775	302.215	374	0.000
	MCH	375	21.4261	1.15481	0.05963	359.292	374	0.000
	MCHC	375	23.0312	1.84687	0.09537	241.488	374	0.000
12 to 14 years	PCV	57	35.6719	2.26367	0.29983	118.974	56	0.000
	MCV	57	68.8456	4.67406	0.61909	111.204	56	0.000
	MCH	57	21.5123	1.15636	0.15316	140.453	56	0.000
	MCHC	57	22.9158	1.57897	0.20914	109.572	56	0.000

Statistical Analysis of Data

Comparison of Gradation of Anemia with Hb percentage and age of child and gender of child

Anemia Gradation as per WHO	N	Hemoglobin gm/dl
Normal	103	12.6 ± 0.54
Mild	374	11.01 ± 0.58
Moderate	23	9.11 ± 0.3

Average range of hemoglobin in normal child was observed to be 12.6 ± 0.54. In Mild anaemic child it was observed 11.01 ± 0.58 while in moderately anaemic child it was observed to be 9.11 ± 0.3. It means maximum number children having mild anaemia with range of 11.01 ± 0.58 range of Hb.

Table 3: Percentage of Children in particular age groups on the basis of Anemia gradation – analyzed with chi square test

Anaemia Gradation	Age of Child	Frequency	Percent	P value
Normal	6 to 8 years	13	12.6	> 0.05 (NS)
	9 to 11 years	79	76.7	> 0.05 (NS)
	12 to 14 years	11	10.7	> 0.05 (NS)
	Total	103	100.0	> 0.05 (NS)
Mild	6 to 8 years	49	13.1	> 0.05 (NS)
	9 to 11 years	280	74.9	> 0.05 (NS)
	12 to 14 years	45	12.0	> 0.05 (NS)
	Total	374	100.0	> 0.05 (NS)
Moderate	6 to 8 years	6	26.1	> 0.05 (NS)
	9 to 11 years	16	69.6	> 0.05 (NS)
	12 to 14 years	1	4.3	> 0.05 (NS)
	Total	23	100.0	> 0.05 (NS)

The percentage of Normal, moderate and mild anemia in different age group was found no significant during the comparison. Mild Anemia is observed 13.1%, 74.9% and 12%; in age between 6-8 year age group, 9-11 year age group and 12-14 year age group respectively.

Table 4: Prevalence of Anemia as per WHO gradation in different age groups – Chi Square

Anaemia Gradation	AGE OF CHILD	FREQUENCY	PERCENT	P value
Normal	6 to 8 years	13	**2.6%**	> 0.0.5 (NS)
	9 to 11 years	79	**15.8%**	> 0.0.5 (NS)
	12 to 14 years	11	**2.2%**	> 0.0.5 (NS)
Mild	6 to 8 years	49	**9.8%**	> 0.0.5 (NS)
	9 to 11 years	280	**56%**	> 0.0.5 (NS)
	12 to 14 years	45	**9%**	> 0.0.5 (NS)
Moderate	6 to 8 years	6	**1.2%**	> 0.0.5 (NS)
	9 to 11 years	16	**3.2%**	> 0.0.5 (NS)
	12 to 14 years	1	**0.2%**	> 0.0.5 (NS)
Total	**500**	**100%**		

From above table it is clear that 20.6% children are having normal or above normal hemoglobin as per WHO classification of anemia; 74.8% children are having mild anemia and 4.6% children are having moderate anemia. In all ***79.4%*** (74.8 + 4.6) of children have anemia. It shows the escalating magnitude of prevalence of IDA in rural Gujarat. Prevalence is more in age group of 9-11 age children (56%).

Table 5: Chi Sqaure Test Analysis

			Anaemia Gradation Acc WHO			Total	P
			Normal	Mild	Moderate		
Gender of Children	Male	Count	58	305	14	377	
		% within Gender of Children	15.4%	80.9%	3.7%	100.0%	0.000 (S)
		% within Anaemia Gradation Acc WHO	56.3%	81.6%	60.9%	75.4%	0.000 (S)
		% of Total	11.6%	61.0%	2.8%	75.4%	0.000 (S)
	Female	Count	45	69	9	123	
		% within Gender of Children	36.6%	56.1%	7.3%	100.0%	0.000 (S)
		% within Anaemia Gradation Acc WHO	43.7%	18.4%	39.1%	24.6%	0.000 (S)
		% of Total	9.0%	13.8%	1.8%	24.6%	0.000 (S)
Total		Count	103	374	23	500	
		% within Gender of Children	20.6%	74.8%	4.6%	100.0%	0.000 (S)
		% within Anaemia Gradation Acc WHO	100.0%	100.0%	100.0%	100.0%	0.000 (S)
		% of Total	20.6%	74.8%	4.6%	100.0%	0.000 (S)

There is statistical significant correlation found between the gender and gradation of anemia in present study. More prevalence in male (83.7%) compare to female (63.4%) shows statistical significant correlation (P-0.000) with the WHO anemia gradation with gender.

Table 6: Pearson's correlation of hematological indices with each other in different categories of WHO classification of Anemia

Anaemia Gradation Acc WHO	Parameters	Haemoglobin gm/dl	PCV	MCV	MCH	MCHC
Normal	Haemoglobin gm/dl	1				
	PCV	0.227*	1			
	MCV	0.016	-0.189	1		
	MCH	-0.095	-0.129	0.012	1	
	MCHC	-0.101	-0.133	-0.115	0.133	1
Mild	Haemoglobin gm/dl	1				
	PCV	0.024	1			
	MCV	-0.031	0.068	1		
	MCH	0.034	0.040	0.043	1	
	MCHC	0.119*	-0.001	-0.006	0.043	1
Moderate	Haemoglobin gm/dl	1				
	PCV	0.306	1			
	MCV	0.430*	0.357	1		
	MCH	-0.145	0.291	0.186	1	
	MCHC	0.160	0.070	-0.191	0.103	1

Hb and PCV were found to be weakly positively correlated, at normal. Mild and moderate anemic patients r (103) = 0.227, $p < 0.05$; r (374) = 0.024, $p > 0.05$; r (23) = 0.306, $p > 0.05$ respectively.

Hb and MCV were found to be weakly positively, weakly negatively and moderately positively correlated, at normal. Mild and moderate anemic patients r (103) = 0.016, $p > 0.05$; r (374) = -0.031, $p > 0.05$; r (23) = 0.4, $p < 0.05$ respectively.

Hb and MCH were found to be weakly negatively, weakly positively and weakly negatively correlated, at normal. Mild and moderate anemic patients r (103) = -0.095, $p > 0.05$; r (374) = 0.34, $p > 0.05$; r (23) = -0.145, $p > 0.05$.

Table 7: Pearson's correlation of hematological indices with each other in different age groups

Age of Child	Parameters	Haemoglobin gm/dl	PCV	MCV	MCH	MCHC
6 to 8 years	Haemoglobin gm/dl	1				
	PCV	-0.139	1			
	MCV	0.032	-0.037	1		
	MCH	-0.103	0.026	0.137	1	
	MCHC	0.020	0.076	-0.156	-0.050	1
9 to 11 years	Haemoglobin gm/dl	1				
	PCV	.108*	1			
	MCV	0.080	0.031	1		
	MCH	-0.083	-0.024	-0.004	1	
	MCHC	0.023	-0.070	-0.017	.110*	1
12 to 14 years	Haemoglobin gm/dl	1				
	PCV	0.111	1			
	MCV	0.058	0.208	1		
	MCH	-0.019	0.107	0.207	1	
	MCHC	0.153	0.169	0.011	-0.161	1

Pearson's r data analyses revealed a **moderate negative** correlation, r=Statistical significance level (p=0.001).

Discussion

The present study attempted to assess the association of haematological indices with the prevalence of anemia among children in the rural surroundings of Vadodara city, Gujarat India.

The mean Hb among school age boys was significantly lower than girls. Sahu et al. also found a lower mean Hb level in school age boys than girls in their research study(4).The prevalence of anaemia among preschool children was 52.5%, which is much less when compared to the state data of 92.4%(5). The type of anemia among school age children was 69.4% (mild 64.8%, moderate 4.6%). Girls were significantly more anemic than boys in the age group of 12-14 years while more boys were anemic in the age group of 09-11 years. Similar results were reported for school children in Bangalore where prevalence of anemia was higher in boys aged 10 years whereas it was high in girls aged 11 years (6).The mean HCT,MCV, andMCH of school age boys were significantly lower than girls. Zemel et al() observed a significantly lower HCT among boys than girls of school age sickle cell children (excluding children receiving transfusion therapy). In this study chronic under nutrition (stunting)maybe one of the factors for lower level of HCT. Kokore et al.found that MCV and MCH are statistically higher for girls than their male counterparts aged 5–11 years. The hypochromasia (MCH deficient) and microcytosis (MCV deficient) in school age population are higher in boys than in girls.The disruption of erythrocyte parameters like MCV andMCH precedes the final stage of anaemia with concurrent falling Hb levels below the limit. In this study, decrease in MCV and MCH might indicate a deficiency in micronutrients including iron and vitamins as suggested earlier (8). Mean MCV and MCH were significantly higher among school age girls than preschool girls. Moreover, MCH and MCHC of preschool children were low compared to schoolchildren. Similar findings were observed among girls of different age groups. Several studies reported an increase in mean MCHand MCHC levels with increase in age.

Hb was positively correlated with RBC, HCT, MCV, MCH, and monocyte in this population. At birth, the total Hb level, RBC, and HCT are shown to be higher than at any other period of life (9). The Hb content and the RBCs then gradually rise to adult levels by the age of puberty (10). Maude et al.(11) even also found RBC correlated positively with total Hb in homozygous sickle cell patients where there is abnormal synthesis of Hb. It was established that the HCT usually correlates well with Hb but is even less sensitive for iron deficiency than Hb (12). The positive association between Hb and MCV suggests a lesser chance of macrocytic anemia in the study population as the concentration of Hb varies concomitantly with cell volume.When RBCs divide in the bone marrow compartment, the resultant two daughter cells after each division are slightly smaller than the parent cell.The reduction in the number of such division's results in the eventual erythrocytes being larger than usual or macrocytic, with a raised MCV leading to an overall reduction in cell division and in a reduction in Hb biosynthesis (13). Khan et al. found significant relationship between Hb and MCH in elderly Pakistani males. Under iron deficiency condition, formation ofHb is reduced resulting in a reduction of MCH (14).

RBC was associated with HCT and monocyte and inversely with MCH. In anemia, a reduction of the Hb is usually accompanied by reduction in the RBC and HCT (15). It was revealed that venous HCT values correlated highly with circulating RBC volume (16). Under autologous experimental conditions, the presence of oxidative stressed erythrocytes in blood exacerbates cytokine production markedly and thus the activation status of human monocytes indicates a probable influence of oxidative stress in these children (17). In anemic condition a marked fall in RBC, Hb, and HCT and a parallel increase in theMCV and MCH were observed. HCT was positively correlated withMCV and monocyte. MCV was found to be associated with MCH and monocyte positively and negatively with the granulocyte.There is a strong association between MCV and MCH in iron deficiency and megaloblastic conditions (18).

In all, there is correlation of Hb with the other hematological indices in our study, which is classical diagnostic marker of IDA.

Pearson's correlation test shows statistical significant correlation of Hb with PCV in 9 to 11 age group of children, but no specific statistical significant level in other age groups with any of the parameters, it suggest that there is no specific statistical significance of prevalence of IDA in specific age group it is equally prevailed among all school going children in our study.

Pearson's correlation test shows statistically significant correlation of Hb with PCV in normal gradation, statistically significant correlation of MCHC with Hb in mild anemia gradation while statistically significant correlation of Hb with MCV in moderate anemia gradation.

Conclusion

Anaemia is a one of the burning issue in the India. Childhood iron deficiency anaemia still continues to be a significant public health problem in children between 5-16 years. Total of 500children were studied in the age group of 5-16 years. 377 (75%) were male children, 123 (25%) were female children. The prevalence of anaemia in children of 6-12 years age was 77%. The prevalence of anaemia in children belonging to lower socio economic status is more than higher socioeconomic status. Contrary to common findings the Male children had higher prevalence of anaemia in all socioeconomic classes in our study. Emphasis on the aggressive drive for the prevention and cure of anemia should be encouraged.

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