Relation between Blood Lead Levels and Childhood Anemia

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Abstract

Background: Lead pollution is a major problem in developing countries. Childhood lead exposure is one of the most significant environmental health threats that affects children. In children, it is defined as a blood lead level equal to or greater than 10 µg/dl. Iron deficiency is a cause of hypochromic microcytic anemia, and also increases the absorption of elements like lead. Anemia in children leads to increased morbidity and mortality. This study was done to determine the relation of blood lead levels greater than 10 µg/dl with the anemia compared to levels less than 10 µg/dl.

Material and Methods: The conduct prospective observational study was conducted on 100 children. For each children haemoglobin, MCV, RDW and blood lead level were tested. 50 children with proven anemia and equal number of children without anemia were enrolled in the study and was analysed and their blood lead levels were tested.

Results: Out of 100 children, 63 were male and 37 were female. The overall children mean age was 73.65 + 52.94 months, male mean age was 73.30 + 51.52 months & female mean age was 74.24 + 55.99 months. The Prevalence of Iron Deficiency Anemia by MCV is 64.2% and Prevalence of Iron Deficiency Anemia by RDW is 58.8%.

Conclusion: Prevalence of Iron Deficiency anemia by MCV and RDW was 64.2% and 58.8%. However there was a significant difference between the anemic and Non anemic group regarding MCV and RDW. According to the study, there is minimal lead exposure and no lead toxicity in this area.

Keywords: *Lead, Iron deficiency Anemia, Hemoglobin, mean corpuscular volume, Red cell distribution width.*

Introduction

Anemia is a common phenomenon worldwide with a higher prevalence in developing countries. More than one fourth of the world's population suffers from anemia while iron deficiency anemia (IDA) accounts for half of such cases. It is mostly seen in preschool-aged children and women [(1)].

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Lead pollution is a major problem in developing countries. Diet, air, drinking water and ingestion of paint chips are considered the primary sources of lead exposure in humans; with increased severity and frequency in developing countries through contaminated soil, water and air pollution. Lead poisoning leads to adverse interaction in cellular biochemical reactions, causing many organ malfunction [(2)].

Childhood lead exposure is one of the most significant environmental health threats that affect children. Blood lead level equal to or greater than 10

μg/dl [3], are being associated with adverse behavioral and developmental outcomes. Recently no level less than 10μg /dl is considered safe [4].

Human exposure to lead occurs primarily through diet, air, drinking water and ingestion of paint chips where absorption is increased mainly in persons suffering from iron and calcium deficiency [5].

Environmental lead exposure occurs from automobile exhaust in areas of the world where leaded gasoline is still being used. At home exposure among children may occur either because of ingestion of old leaded chips or because of pigments and glazes used in pottery [6].

Anemia leads to increased morbidity and mortality in children[7]. Adverse health effects of anemia in children include impaired psychomotor development and renal tubular function, poor cognitive performance and mental retardation [8,9].

This study was therefore done to investigate the association of blood lead level ≥ 10μg /dl and the higher risk of anemia of varying severity among children. The study was conducted to study the relation between blood lead leavel and childhood anemia.

Material and Methods

Study Population:

This study was carried out on a total of 100 children from the pediatric ward in Krishna Institute of Medical Sciences, Karad. They were selected by a systematic random sample. Exclusion criteria of cases were children having anemia due to blood disorder. Children were classified into two groups, anemic group (50 children) withHb levels < 11 g/dl and non anemic group (50 children) with Hb levels > 11 g/dl, aged 6 months to 14 years. Mothers of children were informed about the aim of the study and their consent was obtained. Data related to age, gender, residence, source of drinking water, degree of father and mother's education and their occupation, According to the WHO definition of anemia based on hemoglobin level less than 11 g/dl, the studied population was divided into anemic and non anemic groups [10]. The anemic group was further classified into categories of mild (Hb level 10-10.9 g/dl), moderate (Hb level 8-9.9 g/dl) and severe (Hb level < 8 g/dl) anemia. Also, according to serum blood level, the studied population was classified into two groups, <10 μg/dl and ≥10 μg/dl.

Laboratory Investigations:

A venous blood sample was taken from each child and divided into three tubes. The first tube (containing EDTA) used for estimation of hematological parameters using Celtic auto-analyser, these parameters included the red blood cell count (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC), and red cell distribution width (RDW). The second tube (containing heparin) for estimation of lead by the atomic absorption spectrophotometer[11]. The third tube, Hitachi 911 auto-analyser was used for serum iron estimation using Roche reagent kits.

Statistical Analysis

Statistical analysis was done by SPSS statistical package Version 19 .Chi-square test was performed to compare individual characteristics and the t-test was performed to compare the haematological parameters between the two groups. P-value was considered statistically significant if <0.05. Pearson correlation test was used to determine the significant correlations between variables.

Results

In total 100 children were studied, 50 were anemic and 50 were non anemic. The children mean age was 73.65 + 52.94 months (range: 6 months - 14 years);

in total 63 (63%) children were male including 31 (49.2%) in the anemic group and 32 (50.8%) in the non anemic group. Chi square test showed no significant difference between the two groups regarding Gender (p = 0.836) [Table 1].

The frequency distribution of individual characteristics was studied among the anemic and non anemic group (table 1). There is no statistical significant difference was found for all individual characteristics but age is statistically significant among anemic and non anemic group. Also high prevalence of Educated Mothers (90.0%), Educated Fathers (96.0%) and those consuming Tap water (92.0%) among the anaemic and non anaemic group.

Table No.1: Frequency Distribution of Individual characteristics among the Anemic and Non Anemic group.

Variable / Group	Anemic (n = 50)	Non Anemic (n = 50)	P Value
Age			
Pre School (< 6 Years)	38 (76.0%)	16 (32.0%)	< 0.001 (Significant)
School (≥ 6 years)	12 (24.0%)	34 (68.0%)	
Sex			
Male	31 (62.0%)	32 (64.0%)	0.836 (Not Significant)
Female	19 (38.0%)	18 (36.0%)	
Mother Occupation			
Agricultural Work	6 (12.0%)	6 (12.0%)	0.679 (Not Significant)
Other Work	7 (14.0%)	9 (18.0%)	
Home Maker	36 (72.0%)	34 (68.0%)	
Expired	0 (0.0%)	1 (2.0%)	
Student	1 (2.0%)	0 (0.0%)	
Father Occupation			
Agricultural Work	8 (16.0%)	3 (6.0%)	0.178 (Not Significant)
Expired	0 (0.0%)	1 (2.0%)	
Other Work	42 (84.0%)	46 (92.0%)	
Mother Education			
Educated	45 (90.0%)	46 (92.0%)	0.727 (Not Significant)
Illiterate	5 (10.0%)	4 (8.0%)	
Father Education			
Educated	48 (96.0%)	49 (98.0%)	0.558 (Not Significant)
Illiterate	2 (4.0%)	1 (2.0%)	
Source of Drinking Water			
Tap Water	46 (92.0%)	49 (98.0%)	0.359 (Not Significant)
Hand Pump	4 (8.0%)	1 (2.0%)	

In the table no. 2 shows that the 53 were Iron deficiency Anemic and 47 were Non Iron Deficiency Anemic with respect to the Mean Corpuscular Volume. In total 63 children were male including 32 (50.8%) in the Iron Deficiency anemic group and 31 (49.2%) in the non Iron Deficiency anemic group. Chi square test showed no significant difference between the two groups regarding Gender (p = 0.564) [Table 2].

The frequency distribution of individual characteristics was studied among the Iron Deficiency Anemic and Non Iron Deficiency Anemic group with respect to the Mean Corpuscular Volume (table 2). There is no statistical significant difference in all individual characteristics but Hemoglobin is statistically significant among Iron Deficiency Anemic and Non Iron Deficiency Anemic group with respect to the Mean Corpuscular Volume. Also high prevalence of Educated Mothers (88.7%), Educated Fathers (98.1%) and those consuming Tap water (94.3%) were found among the anemia and group. The Prevalence of Iron Deficiency Anemia by Haemoglobin is 64.2% and also statistically significant difference between Anemic and Non Anemic group with Iron Deficiency Anemia.

Table No. 2: Frequency Distribution of Individual characteristics among the Iron Deficiency Anemia and Non Iron Deficiency Anemia group with respect to Mean Corpuscular Volume.

Variable / Group	Iron Deficiency Anemia (n = 53)	Non Iron Deficiency Anemia (n = 47)	P Value
Age			
Pre School (< 6 Years)	32 (60.4%)	22 (46.8%)	0.174 (Not Significant)
School (≥ 6 years)	21 (39.6%)	25 (53.2%)	
Sex			
Male	32 (60.4%)	31 (66.0%)	0.564 (Not Significant)
Female	21 (39.6%)	16 (34.0%)	
Mother Occupation			
Agricultural Work	5 (9.4%)	7 (14.9%)	0.645 (Not Significant)
Other Work	8 (15.1%)	8 (17.0%)	
Home Maker	38 (71.7%)	32 (68.1%)	
Expired	1 (1.9%)	0 (0.0%)	
Student	1 (1.9%)	0 (0.0%)	
Father Occupation			
Agricultural Work	8 (15.1%)	3 (6.4%)	0.227 (Not Significant)
Expired	0 (0.0%)	1 (2.1%)	
Other Work	45 (84.9%)	43 (91.5%)	
Mother Education			
Educated	47 (88.7%)	44 (93.6%)	0.609 (Not Significant)
Illiterate	6 (11.3%)	3 (6.4%)	
Father Education			
Educated	52 (98.1%)	45 (95.7%)	0.916 (Not Significant)
Illiterate	1 (1.9%)	2 (4.3%)	
Source of Drinking Water			
Tap Water	50 (94.3%)	45 (95.7%)	0.748 (Not Significant)
Hand Pump	3 (5.7%)	2 (4.3%)	
Haemoglobin			
Anaemic	34 (64.2%)	16 (34.0%)	0.003 (Significant)
Non Anaemic	19 (35.8%)	31 (66.0%)	

In the table no. 3 shows that the 68 had Iron deficiency Anemia and 32 had Non Iron Deficiency Anemia with respect to the Red Cell Distribution Width. In total 63 children were male including 43 (68.3%) in the Iron Deficiency Anemia group and 20 (31.7%) in the Non Iron Deficiency Anemia group. Chi square test showed no significant difference between the two groups regarding Gender (p = 0.943) [Table 3].

The frequency distribution of individual characteristics was studied among the Iron Deficiency Anemia and Non Iron Deficiency Anemia group with respect to the Red Cell Distribution Width (table 3). There is no statistical significant difference found for all individual characteristics but Age and Hemoglobin is statistically significant among Iron Deficiency Anemic and Non Iron Deficiency Anemia group with respect to the Red Cell Distribution Width. Also high prevalence of Educated Mothers (89.7%), Educated Fathers (95.6%) and those consuming Tap water (94.1%) was found in the anemia group. The Prevalence of Iron Deficiency Anemia by Haemoglobin is 58.8% and also statistically significant difference between Iron deficiency Anemic and Non Iron deficiency Anemic group.

Table No. 3: Frequency Distribution of Individual characteristics among the Iron Deficiency Anemia and Non Iron Deficiency Anemia group with respect to Red Cell Distribution Width.

Variable / Group	Iron Deficiency Anemia (n = 68)	Non Iron Deficiency Anemia (n = 32)	P Value
Age			
Pre School (< 6 Years)	43 (63.2%)	11 (34.4%)	0.007 (Significant)
School (≥ 6 years)	25 (36.8%)	21 (65.6%)	
Sex			
Male	43 (63.2%)	20 (62.5%)	0.943 (Not Significant)
Female	25 (36.8%)	12 (37.5%)	
Mother Occupation			
Agricultural Work	10 (14.7%)	2 (6.3%)	0.612 (Not Significant)
Other Work	11 (16.2%)	5 (15.6%)	
Home Maker	45 (66.2%)	25 (78.1%)	
Expired	1 (1.5%)	0 (0.0%)	
Student	1 (1.5%)	0 (0.0%)	
Father Occupation			
Agricultural Work	10 (14.7%)	1 (3.1%)	0.170 (Not Significant)
Expired	1 (1.5%)	0 (0.0%)	
Other Work	57 (83.8%)	31 (96.9%)	
Mother Education			
Educated	61 (89.7%)	30 (93.8%)	0.776 (Not Significant)
Illiterate	7 (10.3%)	2 (6.3%)	
Father Education			
Educated	65 (95.6%)	32 (100.0%)	0.563 (Not Significant)
Illiterate	3 (4.4%)	0 (0.0%)	
Source of Drinking Water			
Tap Water	64 (94.1%)	31 (96.9%)	0.922 (Not Significant)
Hand Pump	4 (5.9%)	1 (3.1%)	
Haemoglobin			
Anaemic	40 (58.8%)	10 (31.3%)	0.010 (Significant)
Non Anaemic	28 (41.2%)	22 (68.8%)	

Table no. 4 shows that the relationship of Mean Corpuscular Volume and Red Cell Distribution Width between different levels of Anemia. 50 were anaemic and 50 were non anaemic. Out of 50 children were anemic including 17 (34.0%) in the Mild Anemic, 21 (42.0%) in the Moderate anemic and 12 (24.0%) in the severe anemic. The chi-square test showed that there is statistically significant difference between Iron deficiency anemia by haemoglobin levels.

Table No. 4: Relation of Anemia with category of MCV and RDW.

Variable / Group	Haemoglobin				P Value
	Normal (≥ 11 g/dl)	Mild Anemia (10 - 10.9 g/dl)	Moderate Anemia (8 - 9.9 g/dl)	Severe Anemia (≤ 8 g/dl)	
MCV < 70 fL	19 (38.0%)	10 (58.8%)	15 (71.4%)	9 (75.0%)	0.019 (Significant)
MCV ≥ 70 fL	31 (62.0%)	7 (41.2%)	6 (28.6%)	3 (25.0%)	
RDW ≤ 14.5	28 (56.0%)	11 (64.7%)	19 (90.5%)	10 (83.3%)	0.023 (Significant)
RDW > 14.5	22 (44.0%)	6 (35.3%)	2 (9.5%)	2 (16.7%)	

Discussion

Lead pollution is substantial health problem in a developing country like India. The effect of lead on haematological system results inhibition of heme biosynthesis in anemia. This study, a hospital bade prospective study of blood leads levels in children with anemia include analysis of blood lead levels in 100 children.

In our study, Approximately half of the children in this study had haemoglobin> 1 g/dl, which is similar to previous estimate made for children [12,13].

In our study, out of 50 children with anemic, 46 (92.0%) children had drinking water source from tap water, 4 (8.0%) children had source from hand pumps but there was no statistical significance.

In the study done by Jain et. al. [14] and Amal et. al. [12] .children with higher blood lead levels had consumed piped water but there was no statistical significance.

In our study, out of 53 children with Iron deficiency by Mean corpuscular volume < 70 fL, 34 (64.2%) were anemic and 19 (35.8%) were non anemic. Out of 47 children with MCV > 70 fL, 16 (34.0%) were anemic and 31 (66.0%) were non anemic. Also there was statistically significant difference with Iron deficiency anemia in relation to MCV.

In our study, Out of 68 children with Iron deficient by Red Cell Distribution width > 14.5, 40 (58.8%) were anemic and 28 (41.2%) were Non anemic. Out of 32 Children with RDW < 14.5, 10 (31.3%) were

anemic and 22 (68.7%) were Non anemic. Also there was statistically significant difference between Iron Deficiency anemia in relation to RDW.

Ahmed et al [15] concluded that lead exposed iron deficient children had significantly higher blood lead levels as compared to control and observed that iron deficiency combination with lead exposure synergistically elevates blood lead levels and susceptibility to its harmful effects in children is seen. Also indicated that elevated blood lead levels (> 10 mcg/dl) in children were significantly associated with risk of anemia.

In our study, Out of 50 children were anaemic including 17 (34.0%) in the Mild Anemic, 21 (42.0%) in the Moderate anemic and 12 (24.0%) in the severe anemic. The using chi-square test showed that there was statistically significant difference between Iron deficiency anemia by haemoglobin levels.

Conclusion

Prevalence of Iron Deficiency anemia by MCV and RDW was 64.2% and 58.8%. However a significant difference between the anemic and Non anemic group regarding MCV and RDW. Lead levels were measured and higher lead levels >10 mcg/dl noted.According to the study, there is minimal lead exposure and no lead toxicity in this area.

Abbreviations:

IDA - Iron Deficiency Anemia

RBC - Red blood cell count

Hb- Hemoglobin

Hct- Hematocrit

MCV-Mean corpuscular volume

MCH - Mean corpuscular hemoglobin

MCHC-Mean corpuscular hemoglobin concentration

RDW- Red cell distribution width

Ethical Clearance- received from Institutional Ethics Committee of Krishna Institute of Medical Sciences, Karad

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Conflicts of Interest- Nil

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