ORIGINAL ARTICLE

ASSOCIATION OF LEVELS OF SERUM SELENIUM WITH ANEMIA IN PRIMARY SCHOOL CHILDREN

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ABSTRACT

Background and Objectives: The objective of the study was to find out association of serum selenium levels with anemia in primary school children.

Methodology: Primary school children of age 6 to 9 years were included in the study by census method. Hemoglobin levels and red cell indices were performed on Sysmex 1000 i. Serum Iron and Total iron binding capacity (TIBC was performed on semi-automated spectrophotometer (Chem – 7) in patients with hypochromic microcytic anemia. Serum levels of selenium were performed on hydride generation atomic absorption spectrometer (ContrAA 700).

Results: Out of 150 children 55 (36.7%) had anemia and remaining 95 (63.3%) children were non-anemic. Out of 150 children 77 (51%) children had normal selenium level and all these 77 children were non anemic. Remaining 73 (48 %) children had selenium levels lower than normal level and thus had selenium deficiency. Among these 73 children 55 (36.7%) were anemic and remaining 18 (12%) children were non-anemic. Serum selenium levels were lower in anemic as compared with non-anemic children. Selenium levels were significantly associated with anemia with a p value of < 0.01.

Conclusions: Low serum selenium is associated with anemia among primary school children.

Key words: Anemia, Selenium.

INTRODUCTION

Anemia is a condition in which there is decrease in red cell number and quantity of hemoglobin or the volume of packed red cells in the blood.[1] Anemia is a global public health problem which affects both developing and developed countries.[2] It has been recently estimated that 56% of children, less than 5 years of age were anemic in Pakistan.[3] World Health Organization (WHO) global data-base on anemia shows that 42% of preschool and 53% of school age children are anemic in developing countries.[3]

Selenium (Se) is a chemical element found in the plant food mainly. Selenium is present in the soil and the selenium content of the plant food depends on the selenium content of the soil.[4,5] Selenium plays various roles in body. Selenium is a component of selenoproteins also called antioxidant enzymes.[6] Selenium has a very important role in the functioning of the thyroid gland[7] and also has a role in the immune system.[8] Selenium may boost fertility, especially among men.[9] Main cause of anemia is deficiency however, when supplements of Iron and iron other micronutrients were given it reduces only 40 – 60% of the anemia and the remaining percentage of anemia remain unresponsive to the supplementation.[10] It was observed that other micronutrient deficiencies are also present along with iron deficiency. Therefore, anemia may be a consequence of other micronutrient deficiencies.[11]

According to the international data selenium deficiency is an important and independent risk factor for the development of anemia. In a study conducted on adults of Vietnam it was found that selenium levels were low in anemic adults as compared to the non-anemic adults. In a study of older adults living in US, low selenium concentrations were positively correlated with anemia.[12] Low selenium levels were associated with anemia among school children in Vietnam.[13]

Glutathione peroxidase is an enzyme that plays a major role in protection of erythrocytes against free radicals and oxidative stress. This enzyme contains selenium and therefore selenium is indirectly involved in the prevention of oxidative damage to erythrocytes.[14]

Hemeoxygenase-I is an enzyme that plays a role in the reduction of heme to biliverdin, carbon monoxide, and free divalent iron. When there is Selenium deficiency it can do up-regulation of hemeoxygenase-I which may lead to anemia. Hemeoxygenase-1 demonstrates anti-inflammatory properties and it may be a reason of a chronic inflammatory syndrome. Furthermore, hemeoxygenase-1 also causes the release of iron from the core of the heme molecule. It leads to the ra-

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pid expression of the iron-sequestering protein ferritin and an ATPase pump that actively removes intracellular iron from the cell.[15]

Selenium can also cause anemia through its involvement in the modulation of inflammation. Adults who had anemia of chronic inflammation were found to have low selenium levels in their serum. Disabled older women living in US showed low serum selenium concentrations and a rise in interleukin-6.[16] Selenium can play a part in the anemia of chronic inflammation through its involvement in the upregulation of interleukin-6, Moreover, Interleukin-6 is concerned with the up-regulation of hepcidin, which is an iron regulatory hormone. This hepcidin is involved in the anemia of chronic inflammation through its central role in regulation of iron metabolism. This also provides a link between iron metabolism, inflammation and innate immunity.[17]

Selenium deficiency is also known to cause anemia in the animals like the hemolytic anemia.[18]

It has been observed in the animal studies that if ideal concentration of glutathione peroxidase in erythrocytes is maintained it shows a protective effect to erythrocyte against oxidative damage. This suggests that increased oxidative stress could be another contributing factor to the development of anemia due to selenium deficiency.[19]

MATERIALS AND METHODS

Prior to start of the study, ethical permission was obtained from the University of Health Sciences, Lahore, Pakistan. The study was conducted in the Department of Biochemistry, University of Health Sciences Lahore. Lahore city is divided into nine administrative zones. Out of these nine zones, one zone was randomly selected that was Nishtar Town Lahore. List of Government Primary Schools of Nishtar Town was taken from Executive District Officer Education (EDO) Lahor. One Government Primary School of Nishtar Town was randomly selected. School was Government Primary School Green Town Lahore.

Inclusion Criteria

Children of randomly selected Primary School of age 6 to 9 years were included in the study by census method. All children between this age group who are attending the school were screened for anemia.

Exclusion Criteria

Children suffering from any acute or chronic illness were excluded from the study. Children taking any medication were also excluded from the study.

Hemoglobin levels and red cell indices were performed on Sysmex 1000 *i*. Serum Iron and TIBC was performed on semi-automated spectrophotometer (Chem – 7) by using kits of Randox in patients with Hypochromic Microcytic anemia. Serum levels of selenium were performed on hydride generation atomic absorption spectrometer (ContrAA 700). As no child had Macrocytic anemia so Serum levels of folate and vitamin B_{12} were not performed. The data were entered and analyzed by using standard SPSS software version-16 (SPSS Inc, Chicago) for statistical analysis.

Mean ± SD were given for continuous variables like serum selenium, Serum iron, serum TIBC, hemoglobin etc.

Regression analysis was used to find the significant predictors of anemia. p-value < 0.05 was considered as statistically significant.

RESULTS

One fifty (150) primary school children were included in the study. There were 68 (45.4%) females and 82 (54.6%) males. The mean age of the children was 7.56 ± 1.2 years (range 6 to 9 years). Forty eight (32%) children were of six years of age, 14 (9.2%) belonged to 7 years of age, 40 (26.3%) were eight years and 48 (32%) were of 9 years of age.

Table 1: *Mean±SD and ranges for Quantitative Variables.*

Parameter	*Mean ± SD*	*Minimum*	*Maximum*	*Range*
Hb (g/dL)	11.5 ± 1.4	7.60	14.00	6.40
MCV (fL)	75.5 ± 5.3	54.0	88.0	34.0
MCH (pg)	26.1 ± 3.1	13	31	18
MCHC (g/dL)	32.5 ± 2.5	24	38	14
Serum Iron (µg/dL)	69.4 ± 26.8	24	120	96
TIBC (µg/dL)	351.1 ± 102.7	198	596	398
Serum Selenium (µg/L)	38.6 ± 1.74	9.00	69.00	60

Children were labeled as anemic and non-anemic on the basis of WHO criteria for the age (6 – 9 years) and sex of the children. (WHO, 2011). Children having Hb level less than 11.5 g/dl were labeled as anemic and children having Hb level ≥ 11.5 g/dl were labeled as non-anemic.

Out of 150 children 55 (36.7%) had anemia and remaining 95 (63.3%) children were non-anemic.

There were total 48 children of 6 years of age. Among them 21 (38.2%) were anemic. Out of 14 children of 7 years of age 10 (18.2%) had anemia. 40 children were of 8 years of age and among these children 13 (23.6%) had anemia. 48 children were of 9 years of age and 11 (20.0%) had anemia. Maximum percentage of

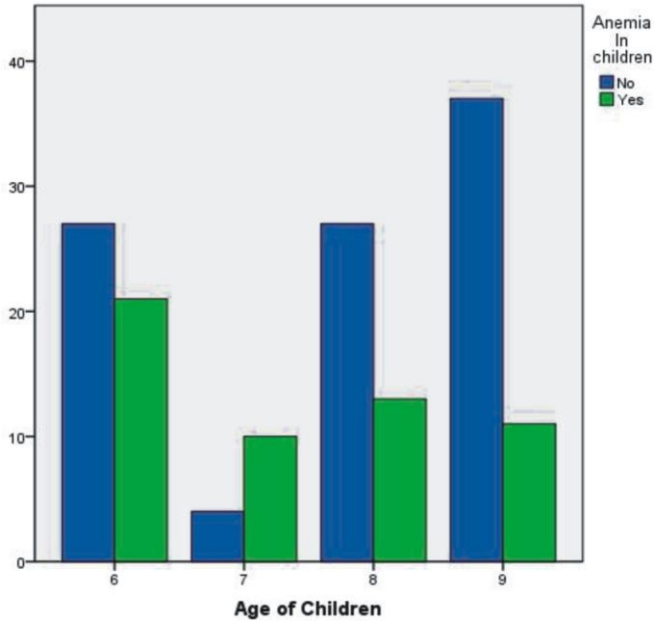

Fig. 1: *Bar Graph of the anemia and age of children (n = 150).*

Table 2: *Serum iron and anemia.*

	Anemia		*p-Value*
	Yes (Mean ± SD)	*No (Mean ± SD)*	
Serum Iron (µg/dl)	68.29 ± 28.2	78.57 ± 6.13	0.026

anemia was observed in children with 6 years of age.

Out of 150 children 77 (51%) children had normal selenium level and all these 77 children were non anemic. Remaining 73 (48%) children had selenium levels lower than normal level and thus had selenium deficiency. Among these 73 children 55 (36.7%) were anemic and remaining 18(12%) children were non anemic. Serum selenium levels were lower in anemic as compared with non-anemic children. Selenium levels were significantly associated with anemia with a *p* value of < 0.01.

All of 55 (36.7%) children who were anemic had iron deficiency which co-existed with selenium deficiency. The difference of serum iron in anemic and non-anemic group was significant with a *p* value of 0.026.

Logistic regression analysis was applied. Model I was developed for males and those who had low serum iron. The logistic model predicted the observed model 88.7%. The odds ratio of gender (Male) was 0.212, for iron deficiency 0.986. Odds ratio for age group 6, 7, 8 and 9 was 0.96, 0.576, and 0.449 and 0.391 respectively. These all odds ratios were not significant.

Model II was developed for females and those who had iron deficiency. Odds ratio for gender (Female) was 4.718 thus females are 4.718 times more likely to develop anemia than males. Odds ratio for iron deficiency was 0.986, for age group 6, 7, 8 and 9 years were 1.161, 0.904, 0.01 and 2.59 respectively. These all odds ratios were not significant

DISCUSSION

In our study anemia is extremely high occurring in 36.7% of the study subjects. This study is comparable to other studies on prevalence of anemia in Pakistan Hamdani and Hashmi,[19] Paracha,[20] Molla,[21] Idris, and Anis.[22]

Various studies have been done to determine association between serum selenium and anemia. The present study demonstrated a strong association of low serum selenium with anemia (p-value < 0.01). This is comparable to other studies in which they found an association between low serum selenium and anemia.

First time the effects of selenium deficiency were studied in hens in 1977 by Latshaw, et al.[23]

In 1984 Morris, et al,[24] suggested that there is a relation between selenium deficiency and anemia in cattles. Hu, et al,[25] found that there is no association between serum selenium and anemia in rats.

In humans, association of selenium deficiency and anemia is described by Hampel, et al,[26] among dialysis patients and it was found in adults with pulmonary tuberculosis.[27]

In a Survey of British National Diet and Nutrition it was found that there is a positive correlation between low plasma selenium concentrations and low hemoglobin among 1134 men and women aged 65 years and older.[28]

It was found in a study that both HIV - infected and HIV uninfected populations had decreased plasma selenium concentrations and decreased hemoglobin concentrations.[27]

Disabled women of old age living in the community demonstrated low serum selenium along with anemia.[12]

Van Nhien, et al, found an association between the occurrence of anemia and decreased levels of trace elements in girls of adolescent age living in rural Vietnam. This study showed that low serum selenium is an independent risk factor for the development of anemia in adolescent girls of rural Vietnam.[29]

In ***conclusion***, it is found in our study that low serum selenium is associated with anemia among primary school children. Though the most common cause of anemia in our study is iron deficiency. This study may signify a first important step toward defining whether selenium deficiency is a possible cause of anemia among primary school children. It is not in our knowledge whether improving dietary selenium intake will increase hemoglobin concentrations in primary school children. Additional work is required to verify these findings in other populations.

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