

## Impact of iron deficiency anemia on cognition of school children of South India

Padmini Thalanjeri<sup>1,\*</sup>, Harish Karanth<sup>2</sup>, Vinutha Shankar MS<sup>3</sup>, Karthiyane Kuty<sup>4</sup>

<sup>1</sup>Assistant Professor, Yenepoya University, Karnataka, <sup>3</sup>Professor & HOD, <sup>4</sup>Professor, Dept. of Physiology, Sri Devaraj Urs Medical College, Kolar, <sup>2</sup>Assistant Professor, Dept. of Anaesthesiology, AJ Institute of Medical Sciences, Karnataka

**\*Corresponding Author:**

**Padmini Thalanjeri**

Assistant Professor, Dept. of Physiology, Yenepoya University, Karnataka  
Email: dr.t.padmini@gmail.com

### Abstract

**Background:** Iron Deficiency Anemia (IDA) is the most widespread anemia among all population segments in India. IDA curtails the oxygen carrying capacity of hemoglobin and thus prevents complete vitality and development of the brain during childhood. Timely intervention and correction of anemia is therefore very important.

**Objectives:**

1. To determine the hemoglobin levels of 30 school children.
2. To perform cognition tests including Raven's score and visual memory test.

**Materials and Methods:** Study included 30 school going children between the ages of 9-13 years. Informed consent was obtained from the guardians. Subjects were screened for anemia by determining Hb (g%) and blood indices. Cognitive function was assessed by Raven's scoring and visual memory test. Cognitive status was then compared between anemic and non-anemic children.

**Results:** Mean age of participants was 10.73 years. 26.66% of the subjects were anemic (mean hemoglobin of 10.42 g%). 73.34% of the participants were non anemic (mean hemoglobin of 12.16 g%). Raven's score was significantly low in anemic children ( $p < 0.001$ ).

**Conclusion:** IDA leads to cognitive impairment and Raven's score is a useful tool to assess it. This impairment can be prevented by timely intervention.

**Keywords:** Cognition, Iron deficiency anemia, Raven's score, School children.

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### Introduction

Reduction of oxygen carrying pigment hemoglobin in blood leads to anaemia.<sup>1</sup> It has become a major public health issue in recent times. Studies have estimated that 25% of population of the world suffer from anaemia and half of them are due to iron deficiency.<sup>2</sup> Iron is essential for the formation of haemoglobin. Many factors are known to cause this nutritional deficiency such low dietary intake, increase in such as puberty, pregnancy and menstruation and demand Iron deficiency anaemia is known to cause several symptoms like fatigue, weakness and also plays havoc to the immune system of our body.<sup>3</sup> In severe anaemia, the need for increased cardiac output results in dyspnoea, palpitation and cardiac failure and complications of pregnancy like short gestation and low birth weight are known to occur.<sup>4</sup> Iron Deficiency Anemia (IDA) is a nutritional anemia which accounts for the major bulk of all the anemia cases suffered by the Indian population. Here, deficiency of iron stores in

the body leads to reduced oxygen carrying capacity of hemoglobin. Many factors have been implicated in the development of this condition. The leading ones being, low iron supplementation, poor absorption from diet due to high content of iron chelators, increased iron demand such as during menstruation, pregnancy and growth spurts etc. Iron deficiency among school going children is a pitiable state as it influences their brain development and interferes with reaching their maximum potential.

Aboud et al in 2002 concluded that children who are deficient in iron, lack the energy, endurance and activity engaged with their environment. Iron deficient children are found to be less involved and interested in their surroundings, unhappier and are often more fearful. This will be reflected in their under performance in learning and work and also mood fluctuations. Consequently, anemic children show impaired cognitive skills like language and motor skills as compared to healthy children. The prevalence of iron-deficiency anaemia which is reported in young children is known to vary in different populations. It is estimated that it ranges from 10% in Western societies to 50% in less developed societies.<sup>2</sup> 1.3 billion people around the world are anemic with nearly half of them having IDA.<sup>2</sup> This problem is more pronounced among the developing nations where it is a major health problem. Timely intervention and correction of anemia

is very important to prevent this cognitive impairment. There are very few such studies done to determine the effect of iron deficiency on cognition among school going children of South Indian population who are about to enter adolescence.

### Materials and Methods

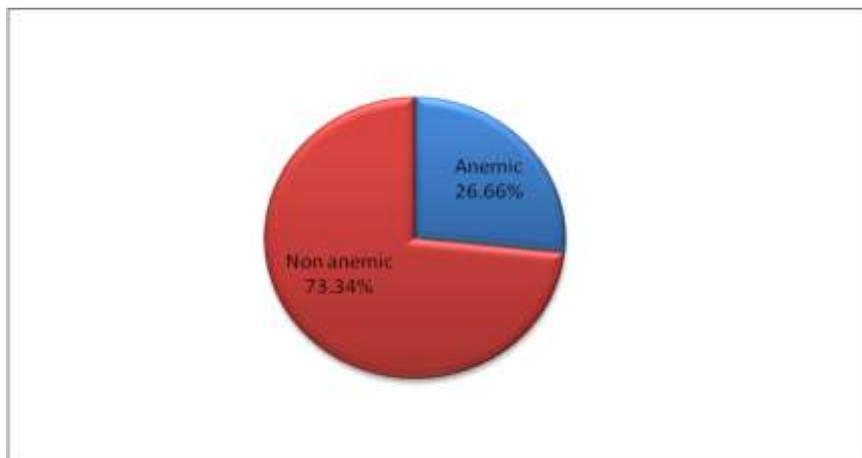
Study included 30 school going children both males and females between the ages of 9-13 years attending a Government school of Tamaka, Kolar district of Karnataka. Ethical clearance was obtained from the Institute's Ethics Committee. Written informed consent was obtained from the parents/guardians of the study participants. Thirty subjects were recruited for this study to detect a minimum difference of 20% of cognition status with alpha of 0.05 and power of 80%. 50% of the samples were females. Female students who had already attained menarche were excluded from the study. General physical examination and detailed developmental history and medical history if any were recorded. 2ml blood was collected by venepuncture

under aseptic precautions in a test tube containing anticoagulant in the Institute's hematology laboratory. Then the subject's RBC count, Hb in g% and blood indices were determined using semi-auto hematology analyzer (Model: FC-717, Beijing Wasson An-Ze Bio-Tech Co., Ltd. Beijing, China) and screened for anemia.

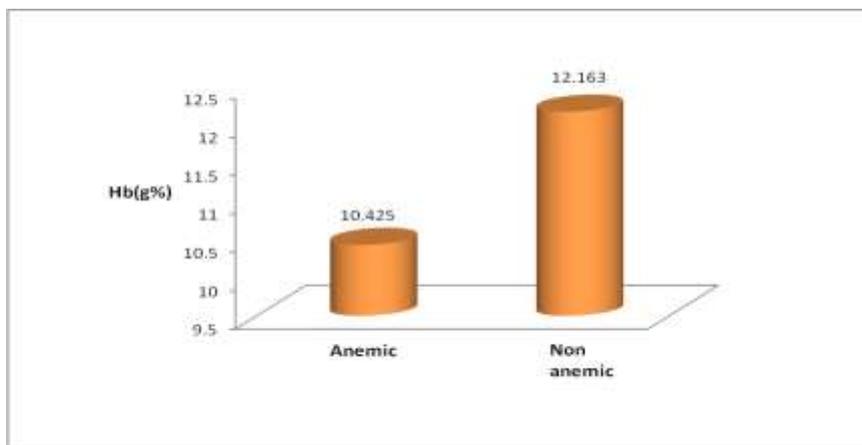
Cognitive function was assessed by visual memory test and Raven's scoring. Visual memory test included 15 pictures. Subjects were shown the pictures for 30 second. Then they were allowed to recollect it for 30 seconds after which they were asked to write it down in 2 minutes. Number of pictures recollected was scored and then tabulated.

Raven's scoring was done by using Raven's standard progressive matrices book. It consisted of several panels consisting of multiple choice questions. Scores were given according to the number of panels identified correctly. Children were classified as anemic due to iron deficiency if their hemoglobin was less than 11.5g% according to WHO cut off value. After this, the cognitive scores of children with anemia were compared with that of children without anemia.

### Results

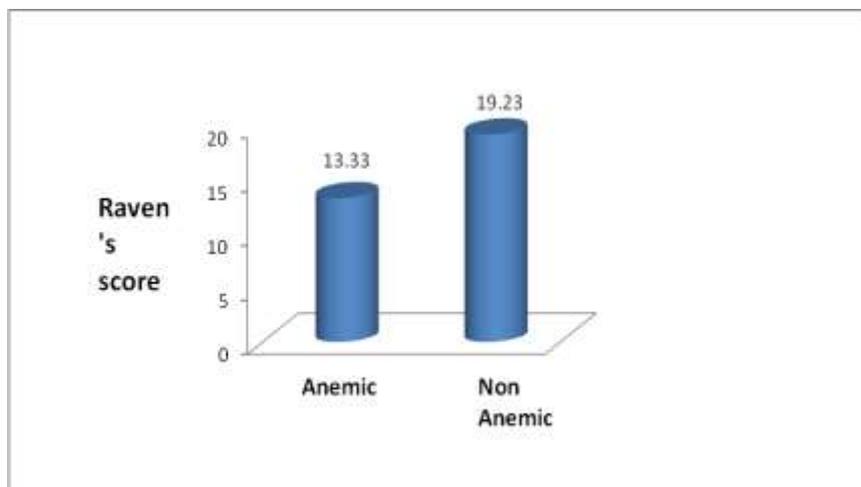


**Fig. 1: Prevalence of anemia in study population**



**Fig. 2: Comparison of haemoglobin concentration among the anemic and non-anemic groups**

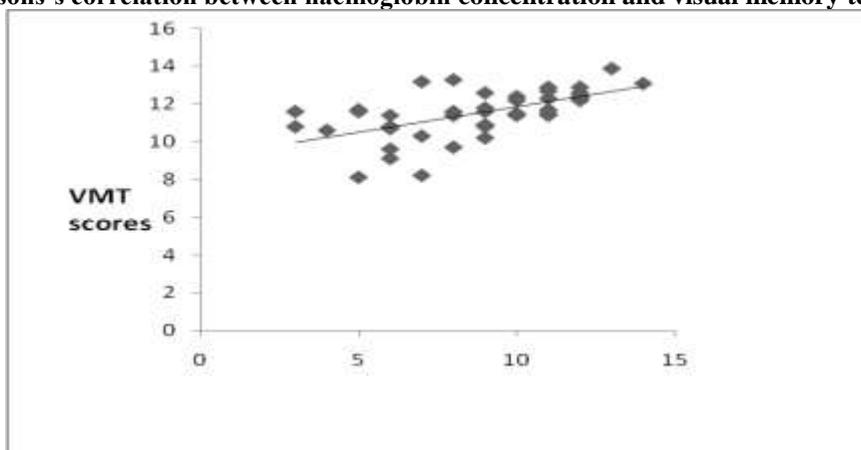
Mean hemoglobin of anemic subjects was 10.42 g% while non anemic subjects had mean hemoglobin of 12.16 g%.



**Fig. 3: Comparison of Raven's score among the anemic and non-anemic groups**

Raven's score was significantly low in anemic children ( $13.5 \pm 3.42$  g%) as compared to non anemic children ( $19.27 \pm 2.41$ g%) with a p value of  $< 0.00$ .

**Graph 1: Pearson's correlation between haemoglobin concentration and visual memory test (VMT) scores**



No significant correlation was observed between visual memory test scores and hemoglobin concentration.

## Discussion

We examined the association between iron deficiency anemia and cognitive development among school aged children. 26.6% of our study subjects were found to be anemic (Fig. 1) with a mean haemoglobin of 10.42g% (Fig. 2). We also found a significant reduction in Raven's score of anemic children (Fig. 3). IDA causes fatigue and decreased attention span, lack of energy to play and reduced motivation. Similar reduction in activity and more submissive behaviour and interaction has also been noted in animal studies.<sup>5</sup>

It has been observed that iron deficient infants and children have reduced attention span and intelligence scores along with delayed psychomotor development.<sup>6</sup> These form cognition which is a representation of higher mental functions and pertains to thought. It is described as pertaining to awareness, orientation to time, place and person, concentration ability, paying attention, memory and intelligence.<sup>7</sup>

Iron needs of the brain are different at different stages of life cycle and cell types of the central nervous system. Iron is an important constituent of many enzymes which are involved in biochemical processes such as oxidation-reduction reactions, synthesis and catabolism of neurotransmitters of the brain and the production of myelin. These biochemical processes play an integral role in regulating the cognitive functions of our brain. Hence changes in iron content may affect these essential functions.<sup>8</sup> Many biological mechanisms are potentially linking iron deficiency with impaired cognitive performance.<sup>6</sup> Iron deficiency translates into depletion of iron stores in body including the brain and these events occur even before erythropoiesis gets affected.<sup>6</sup> Lack of iron disrupts the cerebral oxidative metabolism. This disruption occurs due to depletion of iron-dependent enzymes which have in return known to cause several behavioural abnormalities in animals.<sup>6</sup> Thus, by changes in brain's

iron content and distribution, causes impaired functioning of neurotransmitter which ultimately affects the cognition.<sup>7,9</sup> Certain neuropsychological tests have been useful in earlier studies for determining these cognitive functions. Conversely, it has also been shown that an increase in intelligence quotient scores and development quotient scores can be achieved by enhancing the concentration of hemoglobin.<sup>9</sup> There are documented reversal of cognitive defects following iron therapy.<sup>10</sup> Hence it is essential to detect iron deficiency among the school going children.

However, no significant correlation existed between visual memory test scores and haemoglobin concentration of the subjects in our study (Graph 1). This might be due to the smaller sample size. Earlier studies of IDA in infants showed that IDA affected 2 measures that related most directly to coding and retrieval of memory: object permanence and recognition memory.<sup>9</sup> The highest risk of iron deficiency occurs at times of growth spurt when there is a peaking of nutritional demand.<sup>11</sup>

Iron deficiency affecting oxygen carrying capacity and can also have an impact on immunity, growth and development.<sup>11</sup> Anemia has shown to affect both academic and emotional and behavioral disturbances in school children.<sup>12</sup> Research on preschool children has shown that iron deficient children under performed in psychomotor tests than normal children.<sup>11</sup> In line with other findings we also conclude that iron deficiency anemia has grave consequences on school going children and those entering the adolescent stages. The small sample size and lack of follow up after instituting iron therapy are the limitations of this study. More such studies on a larger population of children of different settings and different age groups along with a follow up study instituting deworming and iron therapy form the future scope of this study. Thus, we conclude that it is very crucial to follow up on the iron status of all school going children and ensure adequate nutrition for helping the children to attain their maximum potential.

### Conclusion

IDA leads to cognitive impairment which can be reversed by appropriate iron therapy. Our study revealed that Raven's score is a simple, cheap and useful tool to assess the cognitive impairment if any, among school going children. Hence, early detection and appropriate treatment should be done mandatorily done among the risk group.

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