

## Original Research Article

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# A study on impact of iron deficiency on cognition and anthropometry in pediatrics and clinical pharmacist's intercession to provide awareness about iron deficiency in tertiary care teaching hospital

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## ABSTRACT

**Background:** Micronutrient deficiencies largely affect pediatric population worldwide. In India, pediatric category is more prone to iron deficiency, the most common micronutrient deficiency disorder which produces haematological as well as non-hematological disturbances. This study aimed to identify the impact of iron deficiency on cognitive function and anthropometric changes in pediatric populations.

**Methods:** A hospital based, prospective observational study was conducted at Department of Pediatrics in Rajah Muthiah Medical College and Hospital, 127 participants were enrolled in this study. BKT kit of Intelligence, Electronic weighing machine, Stadiometer, BMI Calculator by CDC guidelines and patient's haemoglobin values were used in this study.

**Results:** Out of 127 patients, 66 patients had iron deficiency with anemia and remaining 61 had iron deficiency without anemia. Cognitive behaviour was assessed based on the norms and majority were under the category- dull average (52 patients) followed by average (45 patients) and other's had single digit patients. Growth charts of Indian Academy of Pediatrics were used to assess anthropometric characteristics and majority were in the underweight category (61.4%) followed by average category (38.6 %).

**Conclusions:** Low cognitive scores and underweight were found in participants with low haemoglobin levels. Hence, our study provides convincing evidence that iron plays a vital role in the cognition, motor and physical growth. Awareness about the importance of iron and the health issues associated with its deficiency was also provided to the participants.

**Keywords:** Iron deficiency, Cognition, Binet – kamat test, Anthropometry, CDC BMI calculator, WHO – IAP combined chart, Awareness

## INTRODUCTION

Iron is an important micro-nutrients which ensures development of red blood cells and health immune functions includes supporting the metabolism, growth and immunity.<sup>1-3</sup> Iron is essential for myelination of the spinal cord and the grey matter. It is also a cofactor of the

enzymes involved in the synthesis of neurotransmitters, such as tryptophan hydroxylase and tyrosine hydroxylase.<sup>4</sup>

Iron plays an important role in children's growth and development such as brain development, cognitive function, motor function, behaviour and immunity. The iron involves in a lot of metabolic function in the system includes oxygen transport, DNA synthesis and electron

transport. Several evidence of iron deficiency includes more disturbances leads to organ damage.

**Table 1: Effects of iron deficiency based on age (pediatric population).**

Age group	Affects/causes
Infants	Cognitive function, behavior and physical growth
Pre-school aged children	Cognitive function, behavior and physical growth
School aged children	Cognitive function, behavior and physical growth
Adolescents	Physical capacity, Work performance

Iron deficiency is the third major global health problem after obesity and unsafe sex.<sup>5</sup> The infants, preschool children, adolescent female, gastro-intestinal bleeding or urinary tract infection are more prone to iron deficiency. Iron deficiency was higher prevalence in preschool going children followed by adolescent (women).<sup>6-8</sup>

Iron deficiency is defined as condition in which there are no mobilizable iron stores and in which signs of compromised supply of iron to tissues, including the erythron, are noted.<sup>9-11</sup> Many areas of brain contains iron, sometimes in large quantities. People with iron deficiency shows alteration both in neurotransmitters and behaviour which do not respond to iron replenishment usually.<sup>12</sup> It is critical for motor and cognitive development. Cognitive performance are usually impaired by iron deficiency at all stages of life.<sup>13,14</sup>

Various areas like attention, persistence, perception, concentration, visual motor coordination and social comprehension are more evident from the benefit of iron supplementation in cognitive function.<sup>15</sup>

The deficiency of iron adversely affects many functions in the body some of them are as follows with the age groups.

Primarily, this study performance to observe the impact of iron deficiency in cognitive function and physical growth in the pediatric patients.

Secondly, to improve the patient or their parents/care takers knowledge about iron deficiency and their associated problems and enhance the awareness about micronutrient to promote the nutritional status of patients.

#### **Cognitive function**

The cognitive function are purely brain-based skill, the proper development of brain plays a major role in the cognitive function. It was responsible to carry out the any task from the simplest to the most complex. The following mental abilities are collectively referred as cognitive function.

Memory, learning, thinking, remembering, reasoning, problem solving, decision making, attention.

Some of the cognitive assessment scale for pediatrics are as follows:

Binet kamet tests for intelligence, Bhatia battery test of intelligence, VSMS test, Stanford binet test, Wescheler intelligence scale for children.

#### **Binet kamet test for intelligence**

Binet-kamet test is an Indian adaptation of Stanford binet intelligence scale. It is an individual administered intelligence test. This test was revised from original binet-simon scale by LEVIS. M. TERMAN.

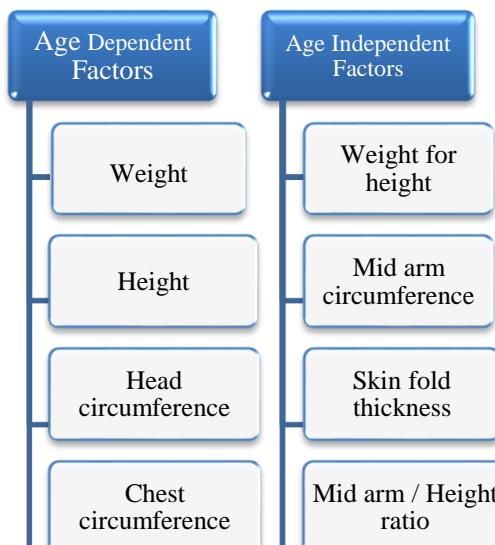
The 5th edition of this intelligence scale was released in 2003, which is used to test the development and intellectual deficiencies in the young children between the age group of 3years to superior adult (12 years).

We had used this scale to perform our study which complies our inclusion criteria and availability of the test kit in our hospital (RMMCH).

In these binet-kamet tests IQ and BKT IQ can be calculated to assess the cognitive functions of the beings with different age groups.

$$IQ = (mental\ age \div chronological\ age) \times 100$$

$$BKT\ IQ = 100 - [(100 - IQ) \times 15] \times (1 \div 18.7)$$



**Figure 1: Anthropometric parameters.**

#### **Anthropometric character**

Anthropometric characters can be calculated by the following parameters.

Apart from this, BMI – body mass index referred as a derived factor to evaluate anthropometry.

### BMI

BMI is defined as a person's weight in kilograms divided by square of the person's height in meters (kg/m<sup>2</sup>). It is a measure for indication nutritional status in adults.<sup>16-21</sup>

In our study we have collected data about height and weight. Then, the BMI of the participants was calculated by using BMI calculator to study the influence of iron in growth of pediatrics group.<sup>22</sup>

## METHODS

### Study design

A hospital based prospective observational study was undertaken from November 2019 to April 2020 in Rajah Muthiah Medical College and Hospital, a 1400 bedded Multi-specialty, Tertiary care teaching hospital located in South India. The study protocol was endorsed by the human research ethics committee of the institute prior to commencement of the study. The sample size was calculated by using the software tool - OPENEPI supported by Centers for Disease Control and Prevention.

### Study participants

#### Inclusion criteria

Pediatric patients of either gender who are between the age group of 1 to 12 years of age admitted in the ward were included in the study. The recruitment of subject was carried out with the help of physician who has knowledge of patient's medical history.

#### Exclusion criteria

Pediatric patients who are all above the age of 12 years, admitted in pediatric intensive care unit, visited pediatric out-patient department and those who are not willing to participate were excluded from our study.

### Study procedure

A self-designed form was developed for collecting the patients full details prospectively such as name, age, gender, chief complaints, diagnosis, drug information with dosage strength and frequency and lab data investigation includes Hemoglobin, MCV, MCHC, PCV, PLT, total RBC and WBC Count until the patients are discharged. Prior to start, the study procedure was explained clearly to the patients parents/guardian who volunteered and fulfilled the inclusion criteria then parental informed consent form was obtained.

After attaining the complete data, we have performed the test and recorded the cognitive ability of pediatrics patients

using the binet-kamet test kit. Cognitive ability can be assessed with the help of score card based on age so that basal, terminal and mental age, pro rated IQ, pro-rated mental age can be calculated. Then collected the anthropometric measurements like height, weight, body mass index, etc from the patients case sheets. Further documented the patients cognitive ability and anthropometry data, cognitive ability tests scores. Analyzed and interpreted the collected data. Reports were submitted.

### Assessment of cognitive ability and anthropometric measures

In this study, the cognitive ability was assessed using binet kamet test for intelligence with help of Intelligence Quotient (IQ) and BKT Intelligence Quotient (BKT-IQ) and an Anthropometric measures calculated by using Height, Weight and Body mass index (BMI) which was globally accepted.

### Statistical analysis

The data was collected and entered in Microsoft excel software 2007 and interpreted by descriptive statistics that was presented to analyze and express the report as counts and percentages in the form of tables.

## RESULTS

A total of 127 pediatric patients were enrolled and it was a male predominant study consisting of 69 males (54.3%) and 58 females (45.6%). Mean age of the population was years. Majority of the patients was in the age group of 3 to 6 years (38.6%) and minority were in the age group of 10 to 12 years with the percentage of 14.2% show in Table 2.

**Table 2: Demographic data of pediatric patients.**

Parameters N = 127(%)		
<b>Gender</b>	Male	69 (54.3)
	Female	58 (45.6)
<b>Age</b>	0 - 3	36 (28.3)
	4 - 6	49 (38.6)
<b>Paying status</b>	7 - 9	24 (18.9)
	10 -12	18 (14.2)
	Free	95 (74.8)
	Concessional	19 (14.9)
	Paying	13 (10.3)

### Disease prevalence

Case sheets of the patients were reviewed and data collected. The disease prevalence of the patients was of two categories based on the following data analysed shown in Table 3.

About 66 patients had iron deficiency with anemia and remaining 61 patients had iron deficiency without anemia.

**Table 3: Disease prevalence categories and their parameters.**

Categories	Lab data analysed
<b>Iron deficiency with anemia (overt anemia)</b>	Hb <12 mg/dl or MCV <80 fl or peripheral smear-showing microcyte or hypochromic RBCs and TIBC more than 400 µg/dl.
<b>Iron deficiency without anemia (latent anemia)</b>	Hb >12 mg/dl or MCV >80 fl. Peripheral smear – Normal, but TIBC more than 400 µg/dl.

**Table 4: Cognitive behaviour assessment norms.**

Norms	Number of patients	Percentage
<b>Very superior</b>	5	3.9
<b>Superior</b>	3	2.4
<b>Bright normal</b>	3	2.4
<b>Average</b>	45	35.4
<b>Dull average</b>	52	40.9
<b>Borderline</b>	8	6.4
<b>Mild MR</b>	5	3.9
<b>Moderate MR</b>	6	4.7
<b>Severe MR</b>	0	0

#### **Assessment result of cognitive behaviour**

Each patient was assessed for his/her cognitive ability using BKT cards, pictures and objects.

From the BKT test kit in his/her native languages. Both verbal and performance tests were conducted for each individuals based on his/her age from the BKT manual. On comparison of their IQ scores with the cognitive behaviour norms, it was observed that more number of the patients were under the category- dull average (52 patients) followed by average (45 patients) and other category had single digit patients (Table 4).

#### **Anthropometric characters**

The most commonly used anthropometric parameters such as height, weight and BMI were used to assess the anthropometry of the participants.

#### **Age dependent factors –height and weight**

Using data recorded in patients' case sheets and stadiometer, heights of the enrolled patients were obtained. Weights of the patients were obtained from case sheets and electronic weighing machine available at Department of Pediatrics. On comparison of patients' heights and weights with the WHO – IAP combined growth charts for Indian male (Table 5) and female kids (Table 6) between the age group of 1 year and 12 years, it was observed that majority of the patients' height were in low range of length velocity (34.7%) followed by mid-range (29.9%), minimum range (29.1%) and maximum range (6.3%) (Table 7). Also, it was observed that, out of 127 patients, 57 were of low weight and 45 of them had minimum weight and 19 had mid-range of weight and finally only 6 were maximum range of growth velocity (Table 8).

**Table 5: Indian growth chart for male kids.**

Min (kg)	Mid (kg)	Max (kg)	Age	Min (cm)	Mid (cm)	Max (cm)
7.5	9.5	12	1	71	75	80
8.5	11	13.5	1.6	77	82	87
9.5	12	15	2	82	87	94
10.5	13	16.5	2.6	85	92	98
11.5	14	18	3	89	96	103
12	15.5	19	3.6	92	100	106
12.5	16	21	4	95.5	103	111
13	17	23	4.6	97	106	115
13.5	18	24.5	5	100	109	118.5
14	18.5	26	5.6	102	112	122.5
14.5	19	28	6	104	115	126
15.5	21	31	6.6	105.5	118	129.5
16	22	33.5	7	109	120.5	132.5
16.5	23	36	7.6	112	123	135.5
17.5	25	39.5	8	114	126	139
18.5	26	42	8.6	116	129	142
19	27	45.5	9	119	131.5	145.5
20	28	48.5	9.6	121	134.5	148.5
21	31	51.5	10	123.5	137	121.5
21.5	32.5	55	10.6	126	140	154.5

Continued.

Min (kg)	Mid (kg)	Max (kg)	Age	Min (cm)	Mid (cm)	Max (cm)
22.5	34.5	58	11	128	142	157
24	37	62	11.6	130.5	145.5	160.5
25	39	66	12	133	148	163.5

**Table 6: Indian growth chart for female kids.**

Min (kg)	Mid (kg)	Max (kg)	Age	Min (cm)	Mid (cm)	Max (cm)
7	8.9	11.5	1	69	79	79
8	10	13	1.6	75	81	86
9	11.6	14.5	2	80	86	92.5
10	12.5	16.2	2.6	84	90.5	97.5
11	14	17.5	3	85.5	95	102
11.5	15	19	3.6	91	99	107
12.5	16	21	4	95	103	111
12.8	16.8	23	4.6	96.5	105.5	115
13	17.2	25	5	97.5	108	118
13.2	18	27	5.6	100.5	111	122
13.8	18.8	29	6	102	113.5	125.5
14	20	31	6.6	105	116.5	128.5
15	21	33	7	107	119	132
16	23	36	7.6	110	122.5	133.5
16.5	24	38	8	112.5	125.5	135
17.2	25.5	41	8.6	115	128	141
18.2	27.2	43	9	117.5	131.5	144.5
19.2	29	46	9.6	120.5	134	148.5
20.8	31	49	10	123.5	137	151
22	33	52.5	10.6	126	140.5	154
23	35.5	56	11	129	143	157
25	37.5	59	11.6	131.5	146	160
26	40	62	12	134	148	162

**Table 7: Percentage of LV of the study participants.**

Range	No. of patients	Percentage
<b>Low</b>	44	34.7
<b>Minimum</b>	37	29.1
<b>Mid</b>	38	29.9
<b>Maximum</b>	08	6.3

**Table 8: Percentage of GV of the study participants.**

Range	No. of patients	Percentage
<b>Low</b>	57	44.9
<b>Min</b>	45	35.4
<b>Mid</b>	19	15
<b>Max</b>	06	4.7

#### *Derived factor – body mass index*

Using BMI calculator published by CDC guidelines, BMI was obtained and assessed from heights and weights of patients. Majority of the participants were in the

underweight category (61.4%) followed by (38.6 %) participants were in average category (Table 9).

**Table 9: Percentage of BMI of the participants.**

Range	No. of patients	Percentage
<b>Underweight</b>	78	61.4
<b>Average</b>	49	38.6
<b>Overweight</b>	0	0

#### **DISCUSSION**

Malnutrition is gradually sloping upwards to breakneck level worldwide. In India, very much confined data was available in this domain. The present was done among pediatric patients with iron deficiency who was admitted in RMMCH. A total number of 127 participants were incorporated in this study, the study shows male preponderance with 54.3% as similar to the study conducted by Naseem et al<sup>4</sup> Majority of the patients were in the age group of 4 – 6 years. From 127 participants, 66 had IDA and remaining 61 had ID without anemia.

In our study, we assessed cognitive ability in all the 127 participants using binet kamet test kit of intelligence with the help of psychiatrics students. From this observation, we revealed that most of the participants in under IQ category (40.9%). This result showed us that the iron deficiency influences in neuro-maturation of the pediatric population. Our study results on cognition were quite similar to the study conducted by Naseem A et al.<sup>4</sup> This report is supported by another two studies conducted by Sarika et al and Mohamed et al respectively.<sup>10</sup> Our study concluded that there is a relationship between iron deficiency and neuro cognitive development.

For anthropometric characters, we studied about weight, height and body mass index. The weight and height measurements were taken from the case sheets of the patients, the collected values are compared with the reference ranges given by IAP and WHO. BMI was calculated by using the body mass calculator for kids and teens published by CDC. Out of 127 patients, 44.9% were under low growth velocity category; 34.7% were under low length velocity category and more than half of the participants 61.4% in underweight group. This study clearly shown that iron deficiency's influence in anthropometry i.e., patients with iron deficiency had growth retardation. this result was similar to the study carried out by Amany et al.<sup>18</sup> Our study clearly evident that the micronutrient deficiency leads to various haematological as well as non haematological disturbances in pediatric population this has to be rectified as soon as possible to ensure the wellbeing of the younger generations.

#### **Clinical pharmacist intercession**

In our study, we provide awareness about the importance of iron, what are the health issues causes due to iron deficiency, what are the foods taken to improve iron level in the body and also to endure the iron absorption, how much iron required in the daily diet as per guidelines given by WHO and CDC.

Also provide awareness about the responsibility of pregnant women to take care during pregnancy period about iron range in the body and to the lactating women those who are with participants included in this study to take iron rich food items because the babies who took breastfeeding by anaemic mothers are prone to get IDA.

#### **Limitations**

The patients between the age group of 1 year to 12 years admitted in In-ward Department of Pediatrics was considered as a limitation. The number of participants obtained and the study duration were limited Due to the pandemic condition. If the study was conducted for long duration, more significant results may have been obtained.

## **CONCLUSION**

This study highlights the importance of micronutrient – Iron's pivotal role involved in Neuro-maturation and Anthropometric developments in pediatrics. The study on this domain was very limited. Therefore, we undertook the present study with broad aim that our data will help to make necessary recommendations to health care professionals as well as parents to ensure nutritional status in paediatrics and a strict balanced nutrient intake policy and guidelines is needed to be framed. This could be impeccably done by multidisciplinary crew comprising physician, clinical pharmacist, nutritionist and nurse join hands to develop a system, structures and policies to monitor and decrease the incidence of micronutrient deficiency and to enhance the wellbeing of pediatric populations.

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