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Effect of iron deficiency on behavior and cognition in children

Karima Abd Elfattah Bahgat
Pediatrics, Faculty of Medicine (for Girls), Al-Azhar University, Egypt

Mahmoud Nasr
Pediatrics, Faculty of Medicine (for Girls), Al-Azhar University, Egypt

Samar Kamel El-Sayed
Pediatrics, Faculty of Medicine (for Girls), Al-Azhar University, Egypt
Corresponding author, email: samarkamel629@gmail.com

***Abstract*---**Background: Iron deficiency (ID) is the most common trace element deficiency in childhood. More than 25% of the world's population is affected by anemia, of which more than 50% suffers from iron deficiency anemia (IDA). Iron deficiency can cause changes in neurotransmitter homeostasis, decrease myelin production, impair synaptogenesis, and decline the function of the basal ganglia. Therefore, IDA adversely affects cognitive functions and psychomotor development. Aim: is to study the effect of iron deficiency on behavior and cognitive function in children using conners parent rating scales and P300 event-related potentials (ERPs). Patients and Methods: This is a cross sectional comparative study included 20 children with iron deficiency, 20 children with iron deficiency anemia,and 20 healthy children who attended the pediatric out patient's clinic and inpatient department of Al-Zahraa hospital –Alazhar University for Girls we include children with iron deficiency ,Children with chronic medical conditions,Children with co-morbid psychiatric diagnoses ,children with any form of psychiatric, physical, developmental or Intellectual disability, chronic underlying disease (e.g. inborn error of metabolism, genetic, endocrine or liver disease, vision or hearing impairment) or neurologic disorders were excluded from the study. Cognitive function was assessed by P300 (ERPs) and behavior disorder assessed by conners parent rating scales Results: Our results revealed a highly statistically significant delay in P300 (ERP)latency in patient groups when compared to control group. And significant increase in affected cases in patient groups than control as regarding cognitive problems , social problems , ADHD index , CGI-Restless Impulsive , DMS-IV Hyperactive –Impulsive score but there is no significant difference as regard of Oppositional problems, hyperactivity, Anxious-Shy,

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Perfectionism, Psychosomatic, CGI-Emotional lability, DSM-IV Inattive score of conner's parent scale. Conclusion: Iron deficiency in children can affect behavior and cognitive function.

***Keywords*---**Iron deficiency, Behavior, Cognition, children, EPR (P300), Conner's parent rating scales.

Introduction

Anemia is defined as hemoglobin below two standard deviations of the mean for the age and gender of the patient. Iron is an essential component of the hemoglobin molecule. The most common cause of anemia worldwide is iron deficiency, which results in microcytic and hypochromic red cells on the peripheral smear. Several causes of iron deficiency vary based on age, gender, and socioeconomic status **(Wawer et al., 2018).**

Iron takes part in a diversity of metabolic processes in the central nervous system. The role of iron in the synthesis of neural transmitters makes it very important for brain development both antenatally and postnatally. The hematoencephalic barrier controls the iron concentration in the cerebral structures. Iron deficiency may result in decreased production of myelin, impaired synaptogenesis, and decline in the function of the basal ganglia, which adversely affect the psychomotor development and mental capacity **(Vallée 2017).**

Event related potentials (ERP) are time-locked specific changes in ongoing electroencephalogram (EEG) activity that occur while the central nervous system (CNS) is processing a stimulus related with sensorial , cognitive or motor function . These changes include series of some negative and positive waves, which were differentiated from background EEG activity by averaging technique **(Akcali et al., 2015).**

P300 is a type of evoked potential wave that measures latency (speed) and amplitude (voltage) in the brain. It relies on auditory and visual stimuli and respective response times to indicate instances of prolonged latency and reduced amplitude. Results can specify changes in cognitive function, especially changes in decision-making and information processes as well as deficiencies in particular neurotransmitters and other prominent electrophysiological abnormalities **(Dinteren et al., 2014).** Several studies elucidate the links between memory and cognitive impairments and negative changes observed in P300 latency and amplitude **(Ozen et al., 2013)**. Because of this evidence, the P300 serves as a sensitive marker for cognitive dysfunction that affects neurological, psychiatric, and developmental areas of the human body **(Braverman et al., 2015).**

The Conners 3 assesses ADHD symptoms and behavior problems known to co-occur with ADHD.The scores obtained version of the Conners 3 have proven to be reliable and valid .The Conners 3 assesses not only dimensional levels of ADHD, CD, and ODD traits, but also DSM-oriented symptom scales and diagnostic categories according to the DSM-5 . The Conners 3VR includes seven content scales (i.e. inattention, hyperactivity/impulsivity, executive functions, learning

problems, aggression, peer relations, and family relations) and four DSM-oriented scales (i.e. ADHD inattentive, ADHD hyperactive/impulsive, ODD, and CD). For all three informant groups, symptoms are rated on a 4-point Likert scale with severity ratings from 0 (not at all/never) to 3 (very much/very frequently). Patients with scores between 40% -60% was considered in the normal range, while scores above 60% or below 40% were considered in the clinical range **(conner, 2008).**

Method

Patients and Methods

This is a cross sectional comparative study included 20 children with iron deficiency, 20 children with iron deficiency anemia, and 20 healthy children who attended the pediatric out patient's clinic and inpatient department of Al-Zahraa hospital –Alazhar University for Girls. Their ages ranged from 6to 10 years .For each patient, clinical diagnosis was established based on a combination of clinical history, physical examination and laboratory investigation

In our study we include children with iron deficiency, Children with chronic medical conditions, Children with co-morbid psychiatric diagnoses, children with any form of psychiatric, physical, developmental or Intellectual disability, chronic underlying disease (e.g. inborn error of metabolism, genetic, endocrine or liver disease, vision or hearing impairment) or neurologic disorders were excluded from the study.

All children included in the study were subjected to the following:Careful full history taking: a detailed performed sheet of medical history including: Demographic data: Age, sex, level of education and school achievement. History of perinatal and /or neonatal insult.,Family history of consanguinity and neurological diseases and Past history: History of medical illeness with special emphasis on etiological causes of iron deficiency e.g. chronic blood loss and **Thorough clinical examination:** which included meticulous general examination with special emphasis on:Detailed physical examination and Complete neurological examination.

Laboratory investigations
5 mL venous blood samples were withdrawn by venipuncture, 2 ml specimens were collected into the K2 EDTA tube for complete blood count (CBC) and 3 mL specimens were collected into plain chemistry tube to clot and sera were separated without delay (immediate centrifugation at 3000 RPM; 15 min), for iron profile

Assessment of behavioural problems by using: Conners` Parent Rating Scale: (arabic version): -It is paper and pencil screening questionnaire designed to be completed by parents. It was developed by C. Kieth Conners ph. D. The Conner's CPRS is an instrument designed to provide a complete overview of child and adolescent concerns and disorders. The Conner's CPRS was used to assess a wide spectrum of behaviors, emotions, academic, and social problems. Scales & Forms: Opposition, cognitive problems, hyperactivity, shies, perfectionism, social

problems, and psychosomatic problems, conner ADHD index, CGI restless-impulsive, CGI emotional lability, DSM-IV inattentive and DSM-IV hyperactive

Patients with scores between 40% -60% was considered in the normal range, while scores above 60% or below 40% were considered in the clinical range.

2-**Assessment of cognitive function** (Auditory P300 event-related potential) by using NEMUS 2 **EBNeuro** measuring system with **Galileo platform, 2-Channels version, Italy**

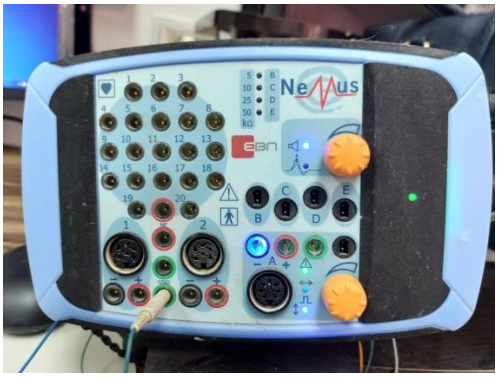

Figure 1: Demonstrate the international 10-20 system of electrode placement of the evoked potential (NEMUS2) used in the current study.

P300 Event related potentials (ERP): The classical P300 deflection emerges in a time locked record as a positivity typically appearing approximately 300 to 400 ms following stimulus presentation. Timing of this component may range widely ,however , from 250 ms and extending to 900 ms , with amplitude varying from a minimum of 5 μv to a usual limit of 20 μv for auditory and visual evoked potentials , although amplitudes of up to 40 μv have also been documented **(coles et al., 1995)7.**

Task and procedure by operator manual

Children in each group were asked to wash his hair by water and soup and avoid putting any gel or oil on his (her) hair the day before the procedure.

Electrodes were applied to the scalp at Fz, Cz , Pz ,and additional 2 electrodes are applied behind the ear bilaterally A1 at right and A2 at left ear.

The skin was cleaned well by special rupping gel with separation of hair to allow good attachment of the electrodes. Ensure proper attachment by check electrode resistance. The test procedure was explained to each child. They were informed that they will hear frequent click sound (frequent stimulus 1000 Hz) that interrupted by another sound of different character and pitch (rare stimulus 2000 Hz) with intensity 65-70dBHL. We allowed each child to hear each sound to ensure they understood the procedure. Children were asked to pay attention to sounds and click on the keyboard he hears the different sound (rare stimulus)

very quickly. Children were comfortably seated on a seat; earphone was applied to their ear. Testing took place in an acoustically isolated and semi-darkened silent room. P300 wave appearing approximately 300 to 400ms following stimulus presentation. The shortest and longest interval (in millisecond) between two frequent stimuli is set by mean of the Inter Stimulus Interval (I.S.I) 1500-2500 (ms) control related to the rare stimulus.

Statistical Analysis

Data were collected, revised, coded, and entered into the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data were presented as mean, standard deviations. Also, qualitative variables were presented as numbers and percentages. So, the p-value was considered significant as the following: P > 0.05: Non-significant, P < 0.05: Significant, P < 0.01: Highly significant.

Results

It revealed:no statistically significant difference between patient group and control group as regard of age ,sex ,weight,height and BMI. Table (1)

Table (1)
Comparison between patient group and control as regard Demographic data

		Control group	**Iron deficiency without anemia**	**Iron deficiency anemia**	**Test value**	**P-value**	**Sig.**
		No. = 20	**No. = 20**	**No. = 20**			
Age (years)	Mean ± SD Range	8.20 ± 1.54 6 – 10	8.20 ± 1.67 6 – 10	8.15 ± 1.35 6 – 10	0.007•	0.993	NS
Sex	Female Male	10 (50.0%) 10 (50.0%)	10 (50.0%) 10 (50.0%)	11 (55.0%) 9 (45.0%)	0.133*	0.935	NS
Weight (kg)	Mean ± SD Range	28.20 ± 8.08 16 – 41	26.35 ± 7.85 14 – 38	25.90 ± 5.67 18 – 35	0.561•	0.574	NS
Height (cm)	Mean ± SD Range	123.50 ± 12.90 98 – 141	120.30 ± 13.66 99 – 140	118.80 ± 10.30 100 – 136	0.753•	0.475	NS
BMI	Mean ± SD Range	18.19 ± 2.35 13.4 – 22.4	17.69 ± 1.82 13.7 – 20.7	18.17 ± 2.47 13.6 – 22.5	0.318•	0.729	NS

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
*: Chi-square test; •: One Way ANOVA test

The mean of HB (g/dl) was 12.87 ± 0.77 in control group and 12.51 ± 0.76 in iron deficiency without anemia and 9.58 ± 1.12 in iron deficiency anemia. There were statistically significant increase in RDW % of patient group when compared to

control, while there were significant reduce in MCV and MCH value. Regarding iron profile ., The mean serum iron of control group was 78.43 ± 14.27 ug/dl , 61.33 ± 10.19 ug /dl in Iron deficiency without anemia group and 53.36 ± 9.48 ug/dl in Iron deficiency anemia group. The mean of serum ferritin was 89.40 ± 26.00 ng/dl in control group, 23.43 ± 4.90 ng /dl in Iron deficiency without anemia group and 15.86 ± 5.55 ng/dl in Iron deficiency anemia group. The mean of TIBC was 291.90 ± 30.38 U/dl, 366.38 ± 41.86 U/dl in Iron deficiency without anemia group and 406.12 ± 48.33 U/dl in Iron deficiency anemia group. Table (2)

Table (2)
Comparison between patient group and control group regarding complete blood count (CBC) parameters and iron profile

CBC		**Control group**	**Iron deficiency without anemia**	**Iron deficiency anemia**	**Test value**	**P-value**	**Sig.**
		No. = 20	**No. = 20**	**No. = 20**			
HB (g/dl)	Mean ± SD Range	12.87 ± 0.77 11.7 – 14.1	12.51 ± 0.76 11.5 – 14.3	9.58 ± 1.12 6.9 – 10.9	80.665•	0.000	HS
MCV	Mean ± SD Range	76.41 ± 9.39 65.2 – 90	77.68 ± 8.02 67 – 90	66.65 ± 5.13 58.9 – 74.1	12.251•	0.000	HS
MCH	Mean ± SD Range	27.44 ± 2.44 24.6 – 33.1	27.25 ± 1.74 24.9 – 30	23.92 ± 2.08 20.9 – 29.7	17.708•	0.000	HS
Platelet (x10^3)	Median (IQR) Range	237 (188 – 335) 140 – 450	220.5 (164.5 – 301) 120 – 610	222.5 (169.5 – 306.5) 37 – 470	0.368≠	0.832	NS
RDW %	Mean ± SD Range	11.93 ± 1.06 11 – 14	14.21 ± 1.35 11.9 – 16.6	15.10 ± 0.71 14.3 – 17	46.371•	0.000	HS
WBCS-total	Mean ± SD Range	8.63 ± 2.82 3.9 – 13	8.27 ± 3.20 4 – 13.6	7.36 ± 2.06 4.5 – 11	1.138•	0.328	NS
Serum iron (ug/dl)	Mean ± SD Range	78.43 ± 14.27 64 – 102.9	61.33 ± 10.19 36 – 76	53.36 ± 9.48 35 – 70	24.760•	0.000	HS
TIBC (U/dl)	Mean ± SD Range	291.90 ± 30.38 252 – 356	366.38 ± 41.86 298.6 – 431.3	406.12 ± 48.33 311.9 – 487	40.259•	0.000	HS
Ferrittin (ng/dl)	Mean ± SD Range	89.40 ± 26.00 59 – 156	23.43 ± 4.90 12 – 30.4	15.86 ± 5.55 8.1 – 29	134.345•	0.000	HS

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
•: One Way ANOVA test

There were a statistically significance increase in P300 (ERP)latency in patient groups when compared to control group. Table (3)

Table (3)
Comparison between patient groups and control group regarding cognitive function assessed by P300 event related potential (ERP) latency.

P300 latency		Control group	Iron deficiency without anemia	Iron deficiency anemia	Test value	P-value	Sig.
		No. = 20	No. = 20	No. = 20			
Fz (ms)	Mean ± SD	215.35 ± 26.82	318.34 ± 55.51	381.28 ± 38.87	79.252•	0.000	HS
	Range	200 – 324	217 – 408.8	280.8 – 426.3			
Cz (ms)	Mean ± SD	221.56 ± 28.60	320.85 ± 58.03	384.13 ± 36.30	73.205•	0.000	HS
	Range	200 – 338.1	230.4 – 417.9	285.2 – 429.3			
Pz (ms)	Mean ± SD	219.47 ± 27.63	321.12 ± 54.79	382.69 ± 37.32	79.030•	0.000	HS
	Range	202.3 – 332.8	223.7 – 411.2	283 – 427.8			

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant
•: One Way ANOVA test

There is significant increase in affected cases in patient groups than control as regarding cognitive problems, hyperactivity, social problems, Psychosomatic, ADHD index, CGI-Restless Impulsive, CGI-Emotional lability, DMS-IV Hyperactive –Impulsive score but there is no significance difference as regard of Oppositional problems, Anxious-Shy, Perfectionism, DSM-IV Inactive. Table (4)

Table (4)
Comparison between patient group and control group as regarding **Conner's parent scale score**

		Control group	Iron deficiency without anemia	Iron deficiency anemia	Test value	P-value	Sig.
		No. = 20	No. = 20	No. = 20			
Oppositional	Not affected	12 (60.0%)	11 (55.0%)	8 (40.0%)	2.728*	0.604	NS
	Affected	7 (35.0%)	9 (45.0%)	11 (55.0%)			
	Borderline	1 (5.0%)	0 (0.0%)	1 (5.0%)			
Cognitive problems	Not affected	16 (80.0%)	7 (35.0%)	10 (50.0%)	10.568*	0.032	S
	Affected	3 (15.0%)	11 (55.0%)	10 (50.0%)			
	Borderline	1 (5.0%)	2 (10.0%)	0 (0.0%)			
Hyperactivity	Not affected	15 (75.0%)	9 (45.0%)	10 (50.0%)	7.724*	0.102	NS
	Affected	2 (10.0%)	9 (45.0%)	9 (45.0%)			
	Borderline	3 (15.0%)	2 (10.0%)	1 (5.0%)			
Anxious-Shy	Not affected	11 (55.0%)	10 (50.0%)	8 (40.0%)	5.723*	0.221	NS

	Affected	5 (25.0%)	9 (45.0%)	11 (55.0%)			
	Borderline	4 (20.0%)	1 (5.0%)	1 (5.0%)			
Perfectionism	Not affected	12 (60.0%)	13 (65.0%)	14 (70.0%)	1.891*	0.756	NS
	Affected	8 (40.0%)	6 (30.0%)	5 (25.0%)			
	Borderline	0 (0.0%)	1 (5.0%)	1 (5.0%)			
Social problems	Not affected	14 (70.0%)	6 (30.0%)	8 (40.0%)	10.037*	0.040	S
	Affected	5 (25.0%)	14 (70.0%)	12 (60.0%)			
	Borderline	1 (5.0%)	0 (0.0%)	0 (0.0%)			
Psychosomatic	Not affected	17 (85.0%)	11 (55.0%)	15 (75.0%)	4.596*	0.100	NS
	Affected	3 (15.0%)	9 (45.0%)	5 (25.0%)			
	Borderline	0 (0.0%)	0 (0.0%)	0 (0.0%)			
ADHD index	Not affected	18 (90.0%)	8 (40.0%)	11 (55.0%)	13.699*	0.008	HS
	Affected	2 (10.0%)	10 (50.0%)	9 (45.0%)			
	Borderline	0 (0.0%)	2 (10.0%)	0 (0.0%)			
CGI-Restless Impulsive	Not affected	17 (85.0%)	12 (60.0%)	7 (35.0%)	14.067*	0.007	HS
	Affected	1 (5.0%)	8 (40.0%)	11 (55.0%)			
	Borderline	2 (10.0%)	0 (0.0%)	2 (10.0%)			
CGI-Emotional lability	Not affected	15 (75.0%)	12 (60.0%)	10 (50.0%)	2.679*	0.262	NS
	Affected	5 (25.0%)	8 (40.0%)	10 (50.0%)			
	Borderline	0 (0.0%)	0 (0.0%)	0 (0.0%)			
DSM-IV Inattive	Not affected	17 (85.0%)	9 (45.0%)	12 (60.0%)	8.779*	0.067	NS
	Affected	2 (10.0%)	10 (50.0%)	8 (40.0%)			
	Borderline	1 (5.0%)	1 (5.0%)	0 (0.0%)			
DMS-IV Hyperactive - Impulsive	Not affected	14 (70.0%)	6 (30.0%)	8 (40.0%)	14.143*	0.007	HS
	Affected	3 (15.0%)	14 (70.0%)	11 (55.0%)			
	Borderline	3 (15.0%)	0 (0.0%)	1 (5.0%)			

P-value > 0.05: Non significant; P-value < 0.05: Significant; P-value < 0.01: Highly significant

*: Chi-square test; •: One Way ANOVA test

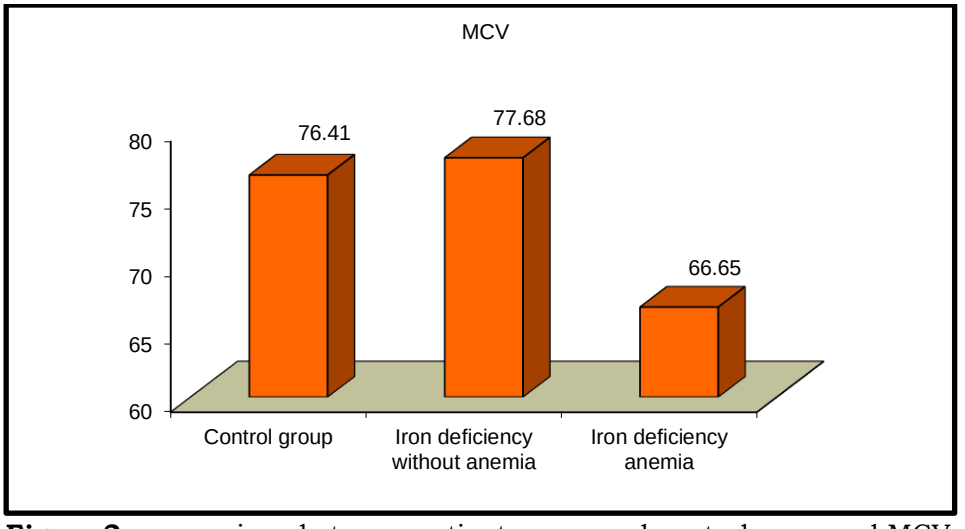

Figure 2: comparison between patient group and control as regard MCV

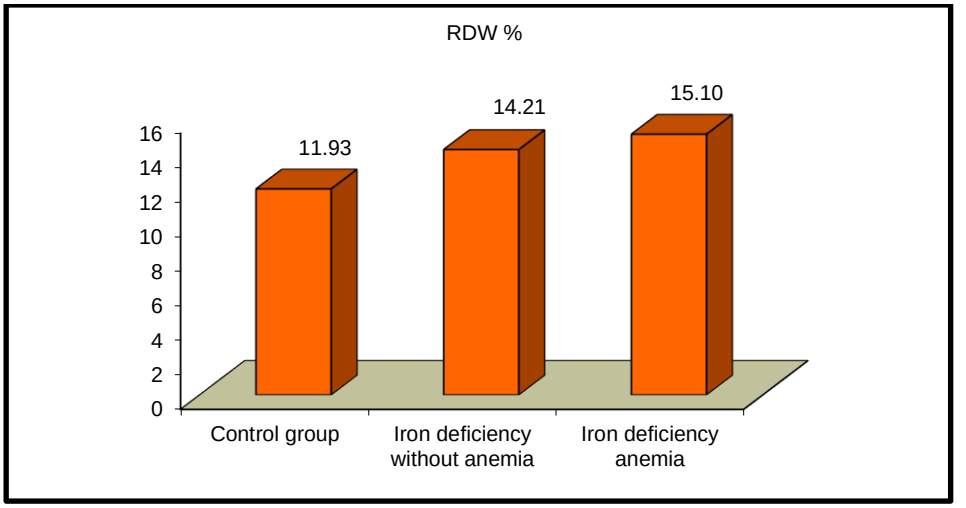

Figure 3: comparison between patient group and control as regard RDW %

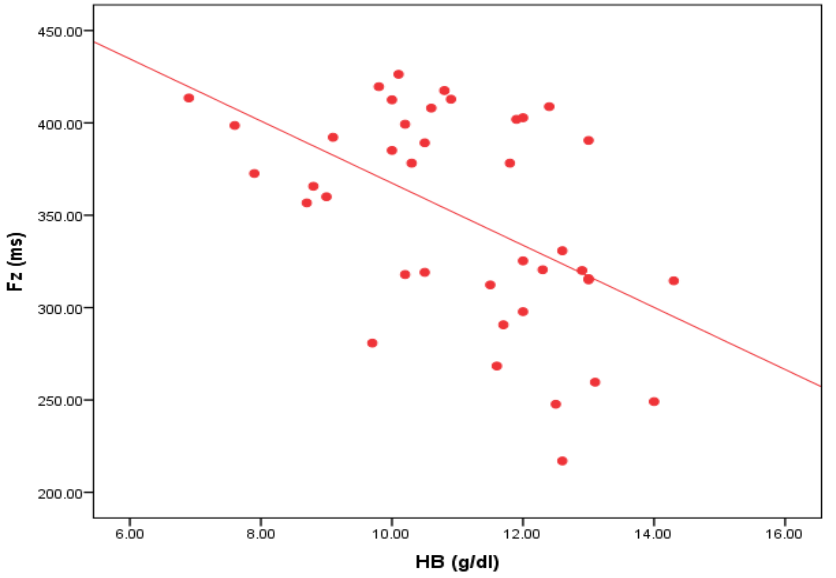

Figure 4: Demonstrates Negative correlation between P300 event related potential (Latency Fz ms) and HB

Discussion

Several studies have investigated the influence of serum iron on cognitive development, but contradictory results have been reported. A few studies have reported that iron deficiency was directly related to both physical and mental development in infants and young children. **(Wang, 2019)**

It has also been reported that iron deficiency may delay, or alter, the structural and functional development of the brain. **(Thomas, 2014)** This may result in poorer IQ level, impaired cognitive functions, poor school achievements and

greater behavioural problems. Indeed, iron deficiency anaemia in children has been associated with poor cognition and school achievements. (**Chauhan, 2016)**
In our study to assess cognitive function for all studied children we use P300 Event Related Potential (ERP), Our results revealed a highly statistically significance delay in P300 (ERP)latency in patient groups when compared to control group

Regarding the auditory event related potential P300, the current study demonstrated a significant delay in latency of P300 waves in patient groups (mean=318.34 ± 55.51 at Fz , 320.85 ± 58.03 at Cz and 321.12 ± 54.79 at Pz) in ID without anemia group and (mean=381.28 ± 38.87 at Fz , 384.13 ± 36.30 at Cz and382.69 ± 37.32 at Pz) in IDA than control group (mean=215.35 ± 26.82 at Fz , 221.56 ± 28.60 at Cz and219.47 ± 27.63 at Pz).

Supporting our finding **Umme Kulsoom Sheema et al., 2020** reported abnormalities in latency of P300 component of ERP in iron deficicent patients, and these abnormalities were indicative of cognitive dysfunction and also **Eman Khedr et al 2008** It was demonstrated that when compared to non- anemic control subjects,with IDA scored less in various cognitive tests and had prolonged p300 latency indicating decreased cognitive performance.

The possible mechanisms explained for reduced cognitive performance and neuro-deficits in IDA are that since iron is an important cofactor required for DNA synthesis and neurotransmitter metabolism, its low levels may inhibit normal physiological functioning; and low hemoglobin in anemia leads to reduced oxygen delivery leading to increased ischemia in these tissues. **(Schieffer et al, 2017)**

Research studies by many investigators revealed that IDA greatly influences cognitive functions in infants, children and adolescents. These clinical studies demonstrated significant positive correlation between blood hemoglobin levels and various cognitive aspects in anemic and non-anemic children and adolescents **(More et al., 2013).**

In our study,There were significant -ve correlation between P300 event related potential (Latency Fz,Cz,Pz ms) and HB(g/dl)and MCH .

Supporting us **Khedr, Eman & Hamed (2008)** reported that P300 latency showed significant negative correlation with Hb levels.

Also, in a study by **Tandon et al., 1996** 15showed a significant correlation between the degree of anemia and P300 latency.

in Iron deficiency anemia group.There were significant –ve correlation between age and P300 event related potential (latency Fz, Cz, Pz ms) .

ALI, Siti Atiyah, et al 2020 also found that Children ages have negative correlation with P300 latencies.

P300 latency has been reported to linearly increase with the increment of age implying that the speed of mental processing slows down during aging **(Uvais et al., 2018).**

Neuroplasticity in the white matter microstructure tract of brain grows significantly during young age and it might play an important factor in influencing reading skills **(Bruckert et al., 2019).**

Tsai, Hung and Tung (2012) 18reported that age related changes in ERP latencies among Taiwanese children significantly regress linearly, while the amplitudes showed a significant linear increase in the P300, P200, N200 and N100 ERP components in an age range of six to thirteen years

Regarding conners parent scale, There was significant increase in affected cases in patient groups than control as regarding cognitive problems, hyperactivity, social problems, Psychosomatic, ADHD index, CGI-Restless Impulsive, CGI-Emotional lability, DMS-IV Hyperactive –Impulsive score but there is no significance difference as regard of Oppositional problems, Anxious-Shy, Perfectionism, DSM-IV Inactive

In our study, There was a significant increase in affected cases in patient groups than control as regarding cognitive problems.

Supporting us **Pivina et al., 2019** reported an association between anemia and impaired cognitive functions such as concentration, intellectual status, memory, and learning skills.

In contrast **(Percinel et al 2015**) reported that there were no significant correlations between with cognitive functions subscale score and iron deficincy.

There was significant increase in affected cases in patient groups than control as regarding hyperactivity subscale score

Supporting us **(Percinel et al 2015)** reported a negative correlation between serum ferritin levels and hyperactivity subscale scores.
Incontrast **Juneja et al 2010** reported that there was no significant correlation of ferritin levels with hyperactivity scores.

There was significant increase in affected cases in patient groups than control as regarding ADHD index score and significance –ve correlation between ADHD index and serum ferritin

Supporting us **Islam et al., 2018** found that serum ferritin level was significantly lower among ADHD patients. This finding is consistent with multiple previous studies and **Cortese et al., 2009** reported that CPRS-ADHD Index score increase in iron deficiency case than control

In contrast to the above-mentioned studies, **Millichap et al., 2006** did not find any significant lowering of serum ferritin among ADHD children. However, he did not have controls in his study. Instead, he compared his findings with national

database. Their findings may suggest that iron deficiency is not a universal finding for ADHD

Also **Percinel et al 2015** reported that there were no significant correlations of iron deficiency with ADHD.

We found no significant increase in Oppositional problems subscale score in iron deficiency

Supporting us **(Percinel et al 2015**) reported no significant correlations with Oppositional problems subscale score

In contrast **Juneja et al 201021** reported that CPRS-ODD score increase in iron deficiency cases

Also The CPRS oppositional scores were significantly correlated with serum ferritin level.

In our study there is no significans difference as regard of DSM-IV Inattive subscale score.
Supporting us **Juneja et al 2010** and **Percinel et al., 2015** reported No significant correlation between ferritin levels and CPRS inattentive scores.

In our study ,There were significant increase in affected cases in patient groups than control as regarding social problems , Psychosomatic , CGI-Restless Impulsive , CGI-Emotional lability , DMS-IV Hyperactive –Impulsive score

In contrast **Percinel et al., 2015** found no significant correlations with these subscale scores.

In our study there is no significans difference as regard of Oppositional problems, Anxious-Shy, Perfectionism, DSM-IV Inattive .

Supporting us **Percinel et al., 2015** found no difference as regard of these subscale scores.

Oner et al., 2008 also found that CPRS and CTRS Total scores were negatively correlated with ferritin, showing that behavioral problems increase with lower iron stores

Conclusion
Iron deficiency in children can affect behavior and cognitive function

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