



Impact Of Iron Deficiency Anemia On Cognitive Performance: A Comparative Analysis Of Cognition In Anemic Iron Deficient, Non Anemic Iron Deficient & Non Anemic Non Iron Deficient Young Women Using Weschlers Memory Scale.

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Abstract

Background: Iron Deficiency starts in utero mainly due to maternal iron deficiency later on brings tremendous effect to fetal brain. Alteration in the brain iron content in early life can persist entirely throughout the adulthood. Insufficient iron stores, in the young brain has a profound irreversible damage on the developing brain. **Objective:** To evaluate and compare the Memory Quotient of Multicomponent wechler's test of Anemic Iron deficient and Non anemic iron deficient study group with the Non anemic Non iron deficient control group in order to rule out the impact of Iron deficiency on cognition in the present study. **Methods:** To analyse the effects of Iron deficiency on cognitive functions in young women this case control study is been done. For this study 81 female subjects in the age group of 18-35 years were chosen divided in to three groups. **Result:** On using a wechler's memory scale all the domains of the test showed a statistical significance between the Non anemic Non iron deficient control (Group 1) & Anemic Iron deficient (Group 2) except for the domain orientation (W2). whereas, Non anemic Non iron deficient control (Group 1) Non anemic iron deficient (Group 3) also showed a high statistical significance except for the domain orientation (W2), visual reproduction (W6). MQ scores showed a high statistical significance between (Group 1) & (Group 2) and as well as between (Group 1) & (Group 3). **Conclusion:** ID with anemia affects "how fast we can complete a cognitive task" whereas Iron deficiency without anemia affects "how well we can perform a simple and complex cognitive tasks."

Keywords: wechler's test, Iron Deficiency, cognitive functions.



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INTRODUCTION

Since the era of its evolution, Iron is the most essential element, preferably channelled for Hemoglobin formation, oxygen transport and storage, cell growth and differentiation, Cognitive function, Immune functions, ATP production, DNA synthesis, effective protection of cells from serious oxidative damage, and Mitochondrial function. The overall concentration of iron in brain is found to be far greater. It is interesting to note that Iron accretion in human fetus begins in early pregnancy and rises significantly in third trimester and continues gradually after birth until 30-50 years of age. (1, 2)

ID and IDA is a well known public health problem in developing countries. In Indian young females, there is multitude of causative factors contributing to iron deficiency anemia to start with it includes inadequate iron intake, poor absorption (diets low in ascorbic acid, and high in iron chelators like phytates) iron demand (growth spurt), menstruation, reproductive tract infection, women of child bearing age (pregnancy), chronic inflammatory states mediated by hepcidin expression, parasitic infestation, micronutrient deficiencies, Hemoglobinopathies, Malnutrition, Poverty, Intrafamilial food distribution affecting females rather than males reflecting the gender discrimination since birth apart from overall lower literacy rate. Various Non hematologic manifestations seen are reduced work capacity, depressed immune function, decreased athletic performance, decreased scholastic performance, growth and development retardation, Impaired cognitive function (3,4).

MATERIALS AND METHODS

This study was conducted at Thanjavur Medical college and Hospital, Thanjavur. The study participants were from Thanjavur. Informed written consent was taken from the participants.

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To analyse the effects of Iron deficiency on cognitive functions in young women this case control study is been done. For this study 81 female subjects in the age group of 18-35 years were chosen divided in to three groups.

- Group I-27 subjects in (Non anemic Non Iron deficient control group)
- Group II-27 subjects in (Anemic Iron deficient study group)
- Group III-27 subjects in (Non anemic Iron deficient study group)

Inclusion Criteria:

- Young women with iron deficiency anaemia

Exclusion Criteria:

- Cardiovascular disease
- Chronic illness
- Diabetes Mellitus
- Hypertension
- Chronic Infection
- Chronic inflammation
- Postmenopausal Women
- Recent Blood donation
- Pregnancy Related Condition (Abortion, Postpartum Period)
- Neurological disorder/Seizures
- Mental retardation
- Psychiatric Illness.

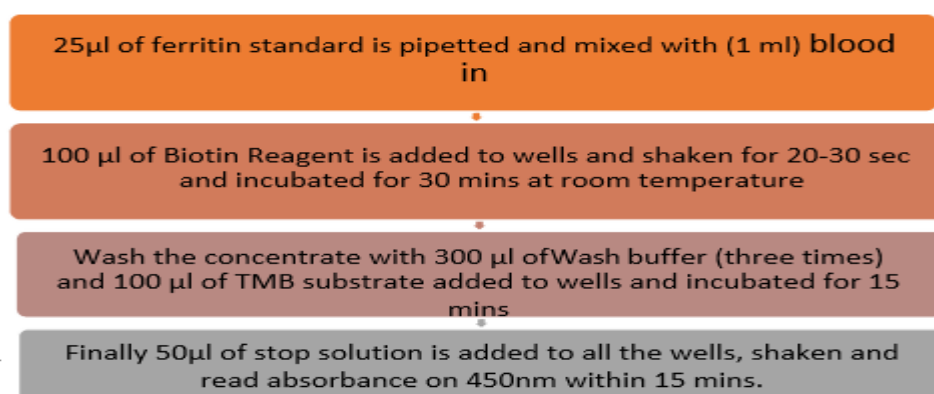
Method of Estimation Of Parameters

Blood samples (2ml) were taken from the study participants and evaluation of the hemoglobin concentration was done by automated analyzer –Beckman coulter counter. Estimation of serum Ferritin concentration to rule out iron deficiency was done by ELISA method.

Reagent Used

- Ferritin standard-0.5ml
- Anti-ferritin Biotin Reagent-12ml.
- Anti-ferritin Enzyme Reagent-12ml
- Wash concentrate-25ml
- TMB Substrate-12ml
- Stop solution -12ml.

ASSAY PROTOCOL



Parameter	Unit	Normal Range
Hemoglobin	gm%	12.0 to 17
Serum Ferritin	ng/ml	Women-10-200

METHOD OF ASSESSING COGNITIVE FUNCTION

MULTICOMPETENT TEST- by Weschler's Memory scale (David Weschler)

Participants in both the study and control group were asked various questions to assess the multiple domains of cognition such as the personal & current information, Orientation, Memory control-Immediate Recall, Digits Backward, Digits Forward and Associative Learning following which scoring is done under Indian norms, by addition of partial subtest scores and age assigned constant is again added to those scores, to obtain raw scores and from which finally the Memory Quotient(MQ) of an individual is obtained.

Statistical Analysis

- Data analysis in this Case-Control Study was done by using IBM SPSS (Statistical Package for Social Sciences) software version 16.0 for windows 10.0.
- Statistical analysis done using Independent t-test was done to find out the significance of difference between Groups I and II and between Groups II and III.
- One way Analysis of Variance (ANOVA) was applied to compare means within and between the three groups.
- The confidence interval was set at 95% and p-value < 0.05 was considered significant.

RESULTS

On using a wechler's memory scale all the domains of the test showed a statistical significance between the Non anemic Non iron deficient control (Group 1) & Anemic Iron deficient(Group 2) except for the domain orientation(W2).whereas, Non anemic Non iron deficient control (Group 1) & Non anemic iron deficient (Group 3) also showed a high statistical significance except for the domain orientation(W2),visual reproduction(W6).MQ scores a showed a high statistical significance between (Group 1) & (Group 2) and as well as between (Group 1)& (Group 3).

TABLE 1: DESCRIPTIVE STATISTICS & COMPARISON OF COGNITIVE SUBSETS SCORES OF WESCHLER'S MEMORY SCALE BETWEEN NON ANEMIC NON IRON DEFICIENT CONTROL (GROUP 1) AND ANEMIC IRON DEFICIENT (GROUP 2) & NON ANEMIC IRON DEFICIENT (GROUP 3) (ONE WAY ANOVA)

WESCHLER'S MEMORY SCALE	GROUP 1 MEAN± SD (n-27)	GROUP 2 MEAN± SD (n-27)	GROUP 3 MEAN± SD (n-27)	F VALUE	p value
PERSONAL & CURRENT INFORMATION (W1)	5.74±.447	5.04 ± .192	6.00 ± .000	85.048	.000< 0.05 Significant
ORIENTATION (W2)	5.04 ±.192	5.00 ± .000	5.00 ± .000	1.000	.373>0.05 Not Significant
MENTAL CONTROL (W3)	8.96 ± .192	8.56 ± .506	8.41 ± .501	12.319	.000< 0.05 Significant
LOGICAL MEMORY- IMMEDIATE RECALL(W4)	13.22 ±4.228	3.56 ± .847	11.33±1.441	102.887	.000< 0.05 Significant
DIGITS FORWARD (W5A)	6.37 ± 1.006	4.63 ± .565	5.19 ± .736	34.212	.000< 0.05 Significant
DIGITS BACKWARD (W5B)	5.19 ± 1.039	3.78± .698	4.26 ± .764	19.268	.000< 0.05 Significant
VISUAL	11.44 ± .641	9.33 ± 1.000	11.00 ± .877	46.035	.000< 0.05

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REPRODUCTION (W6)					Significant
ASSOCIATE LEARNING (W7)	17.81 ± 3.235	9.00±1.038	9.70 ±1.958	126.442	.000< 0.05 Significant
RAWSORE	106.74 ±4.776	81.96±2.579	93.89 ±1.987	372.219	.000< 0.05 Significant

From this table we can infer that the scores of various domains of Weschler's test like personal and current information (W1),Mental control (W3),Logical memory-Immediate Recall (W4), Digit forward (W5A),Digit Backward (W5B),Visual Reproduction(W6),Associate Learning (W7)between and within the groups were highly significant($p<0.000$),whereas Orientation(W2) scores showed a p value of ($p<0.3$).

Raw scores and Memory Quotient of the Weschler's Test in the groups showed a significant difference ($p<0.000$).

COMPARISON OF WESCHLER'S MEMORY SCALE COGNITIVE SCORES AMONG GROUPS.

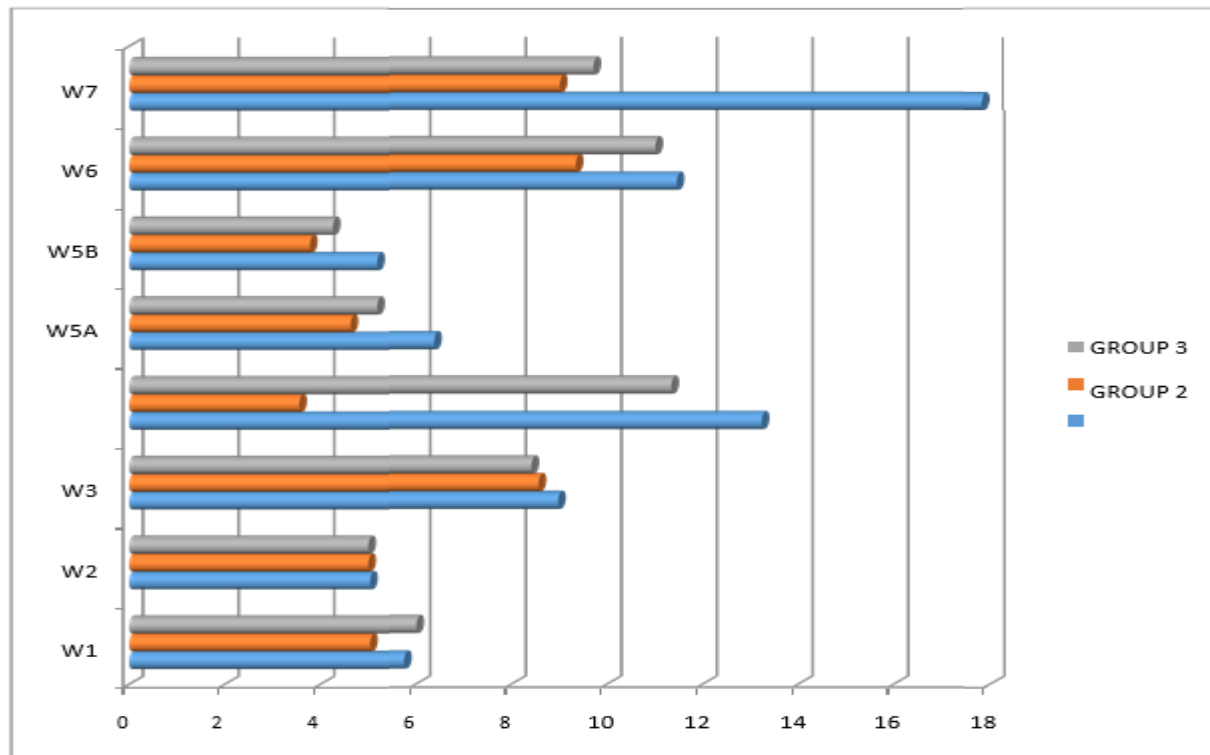


FIG 1: This bar diagram shows the comparison of wechsler's memory scale subtest scores between the Non Anemic Non Iron Deficient Control (Group 1) And Anemic Iron Deficient (Group 2) & Non Anemic Iron Deficient(Group 3) showing that anemic iron deficient groups have very less score compared to the control and Non anemic iron deficient (Group 3).

TABLE 2: COMPARISON OF WESCHLER'S MEMORY SCALE COGNITIVE SUBTEST SCORES IN NON ANEMIC NON IRON DEFICIENT CONTROL GROUP (1) & ANEMIC IRON DEFICIENT GROUP (2). (INDEPENDENT T TEST)

WESCHLER'S MEMORY SCALE	n	GROUP 1 MEAN± SD	GROUP 2 MEAN± SD	P VALUE
PERSONAL & CURRENT INFORMATION (W1)	27	5.74±.447	5.04 ± .192	.000< 0.05 Significant
ORIENTATION(W2)	27	5.04 ±.192	5.00 ± .000	.322< 0.05

				Not Significant
MENTAL CONTROL(W3)	27	8.96 ± .192	8.56 ± .506	.000< 0.05 Significant
LOGICAL MEMOR Y- IMMEDIATE RECALL(W4)	27	13.22 ± 4.228	3.56 ± .847	.000< 0.05 Significant
DIGITS FORWARD(W5A)	27	6.37 ± 1.006	4.63± .565	.000< 0.05 Significant
DIGITS BACKWARD(W5B)	27	5.19 ± 1.039	3.78 ± .698	.000< 0.05 Significant
VISUAL REPRODUCTION(W6)	27	11.44 ± .641	9.33 ± 1.000	.000< 0.05 Significant
ASSOCIATE LEARNING(W7)	27	17.81 ± 3.235	9.00±1.038	.000< 0.05 Significant
RAW SCORE	27	106.74±4.776	81.96±2.579	.000< 0.05 Significant
MQ	27	116.00±10.134	77.15±3.549	.000< 0.05 Significant

This table shows that the difference in scores of Personal and current information(W1), Mental control(W3), Logic memory-Immediate Recall(W4), Digit Forward(W5A),Digit backward (W5B),Visual Reproduction(W6), Associate Learning(W7) between the Non anemic Non iron deficient group (group 1)& Anemic iron deficient(group 2) were highly significant (p<0.000). Orientation (W2) scores in group 1 & group 2 showed a (p value of 0.322) which is not significant.Memory Quotient on comparison between group 1& group 2 showed a statistical significance indicating that the differences exist between the groups.

TABLE 3: COMPARISON OF WESCHLER'S MEMORY SCALE COGNITIVE SUBTEST SCORES IN NON ANEMIC NON IRON DEFICIENT CONTROL GROUP (1) & NON ANEMIC IRON DEFICIENT GROUP (3) (Independent T test)

WESCHLER'S MEMORY SCALE	n	GROUP 1 MEAN± SD	GROUP 3 MEAN± SD	P VALUE
PERSONAL & CURRENT INFORMATION (W1)	27	5.74 ±.447	6.00± .000	.000< 0.05 Significant
ORIENTATION(W2)	27	5.04 ±.192	5.00 ± .000	.322< 0.05 Not Significant
MENTAL CONTROL(W3)	27	8.96 ± .192	8.41 ± .501	.000< 0.05 Significant
LOGICAL MEMOR Y- IMMEDIATE RECALL(W4)	27	13.22 ± 4.23	11.33±1.441	.000< 0.05 Significant
DIGITS FORWARD(W5A)	27	6.37 ± 1.006	5.19 ± .736	.000< 0.05 Significant
DIGITS BACKWARD(W5B)	27	5.19 ± 1.039	4.26 ± .764	.000< 0.05 Significant
VISUAL REPRODUCTION(W6)	27	11.44 ± .640	11.00 ± .877	.000< 0.05 Significant
ASSOCIATE LEARNING(W7)	27	17.81 ± 3.234	9.70 ±1.958	.000< 0.05 Significant
RAW SCORE	27	106.74±4.776	93.89±1.987	.000< 0.05 Significant
MQ	27	116.00±10.134	93.89 ±1.987	.000< 0.05 Significant

This table shows that the differences in Test scores of personal and current information(W1), Mental control(W3),Logic memory-Immediate Recall(W4) ,Digit Forward(W5A),Digit backward(W5B) ,Associate Learning(W7) between the Non anemic Non iron deficient group (Group 1) & Non anemic iron deficient(Group 3) were highly significant ($p<0.000$).Orientation scores(W2) is statistically not significant between Non Anemic Non iron deficient (Group 1)& Non anemic iron deficient (Group 3) showing that no differences exists in this scores between the groups.

Memory Quotient (MQ) were statistically significant ($p<0.000$) between the Non anemic Non iron deficient (Group 1) and Non Anemic iron deficient (Group 3).

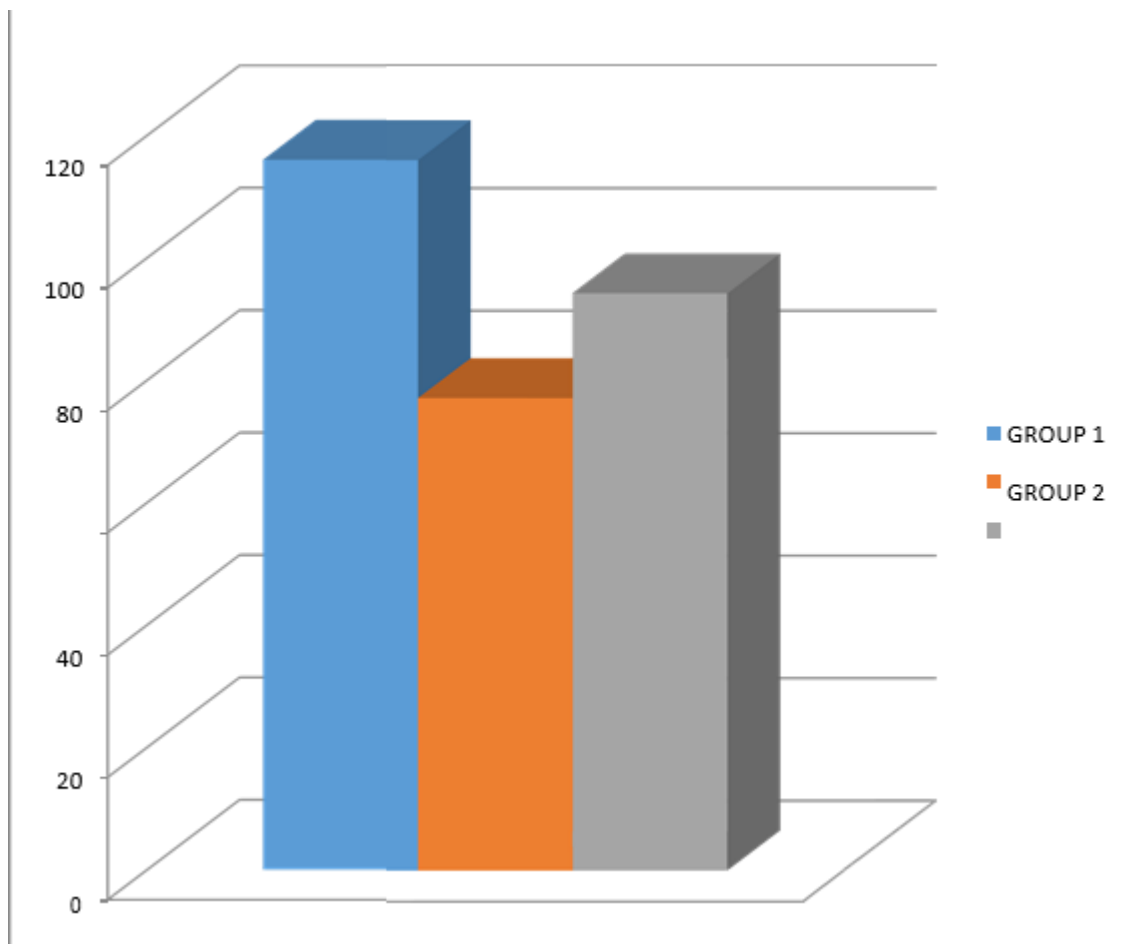


FIG 2: This bar diagram clearly shows the Mean Memory Quotient(MQ)of Non anemic non iron deficient(Group 1) is compared with the Anemic iron deficient (Group2) and Non anemic iron deficient(Group 3)study groups.

DISCUSSION

In accordance with the prospective study by Eman Khedr et al(5) its stated that patients with Iron deficiency anemia, showed a highly significant lower scores on cognitive tests such as Mini mental state examination and in most of domains of Weschler's memory scale.IDA proved to have a deleterious effect in verbal and as well as in performance IQ besides memory. These findings suggest that IDA found to have a negative impact on Intelligence.Our study, also goes well with the results of this study showing a significant lower scores on mini mental status examination in Anemic iron deficient group(16.444 ± 0.84132)& Non anemic iron deficient group(mean- 21.9259 ± 0.91676)compared to Non anemic non iron deficient control group(27.2963 ± 0.95333).Added to it, there was a significant reduction in scores of weschler's memory scale(WMS) cognitive domains, such as Personal & current information,mental control,Logical memory,Digit forward ,Digit backward,Visual reproduction and Associative learning in Anemic iron deficient group & Non anemic iron deficient group than the Non Anemic Non Iron deficient control group indicating that iron deficiency has a significant deleterious impact on cognition in the present study. Jennifer A.Deal et al(6) in his prospective cohort study concluded that association between anemia and cognitive decline is often differential according to domain.Anemia was associated with a more faster

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rate of decline in domains of memory, immediate and delayed recall than the executive function which is consistent with our study showing that on using a wechsler's memory scale Anemic iron deficient (group 2) participant showed a decline in logic memory a a maximum propotion.

Limitation: Weschler's memory scale(WMS) has a statisfactory standardization. We implicated Three Neuropsychological test in cognitive assessment of Iron deficient individuals, eventually much more neuropsychological test with multiple cognitive domains can be performed on participants to bring about a clinching diagnosis from a clinical perspective.

CONCLUSION

Although its highly difficult to identify the cause effective relationship between various factors and the development of iron deficiency and Neurocognitive impairment. Iron deficiency(ID) and Iron deficiency without anemia(ID-A) is more often associated with Poor Behavioural and Cognitive outcomes. The findings of the our study supports the fact that Neurocognitive insufficiency of iron in young women influences the cognitive functions of the study participants in terms of reduction in mathematical score, reduction in test scores on various domains of cognition like Logical memory, Immediate Recall, Digit forward, Digit Backward, Associative Learning, which on long term distrupts the level of IQ. This impairment in young women can have a negative influence on a multistage approach were women are expect to do multitasking being a mother, be at work, or be it in a family environment. ID with anemia affects "how fast we can complete a cognitive task" where as Iron deficiency without anemia affects "how well we can perform a simple and complex cognitive tasks". Thus Eliminating the etiological factors of iron deficiency, initiating a cost effective food fortification program, and taking further measures to hike the amount of absorbable iron intake in targeted population of iron deficiency with and without anemia by subsequent fortification of food by adding EDTA, Hemoglobin, Vitamin C in developing countries like India would be beneficial. Education approach were the importance of Programmes like National Nutritional Anemia control program (NNACP) should be brought to the limelight of young women and children in rural areas by teaching its importance about the consumption of Iron and Folic acid for the prevention of Non Hematological consequences of Iron deficiency .

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