



Original Research Article

## Iron and Zinc Rich Food Supplement on the Nutrition Status and Cognition of School Going Children in Coimbatore

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### ABSTRACT

**Introduction:** Nutritional deprivation is rampant in children of school age particularly primary school children ranging in magnitude from 20-80% (Fazili et al., 2012). Research indicates that health problems due to miserable nutritional status in primary school-age children are among the most common causes of low school enrolment, high absenteeism, early dropout and unsatisfactory classroom performance

**Materials and Methods:** Ninety girls in the age of eight years who were mildly anaemic were selected for the study. The nutrition status was assessed by anthropometric parameters, biochemical estimation of haemoglobin, ferritin levels and zinc levels. The cognition abilities were assessed through six standard cognition tests. Two iron and zinc rich composite flour based cookies were formulated for supplementation along with the standard cookie. Sixty gram of the cookie was given to the children for six month duration. The impact of the supplement on the anthropometric parameters, biochemical parameters and cognition were determined

**Results:** There was a significant increase in the anthropometric parameters when compared with the control group. The mean Body Mass Index value of the children supplemented with the formulated cookies came above the standard value. There was a significant improvement in the biochemical parameters ( $p < 0.005$ ). The cognition scored also improved after the supplementation study.

**Conclusions:** The effect of food based approach in reducing the micronutrient deficiency in school children was evaluated in the study. It can be concluded that use of locally available nutrient rich foods can be used as an effective tool in combating nutrition deficiencies.

**Keywords:** Iron, Zinc, cognition, cookies, school children.

### INTRODUCTION

Nutritional deprivation is rampant in children of school age particularly primary school children ranging in magnitude from 20-80% (Fazili et al., 2012). Research indicates that health problems due to miserable nutritional status in primary

school-age children are among the most common causes of low school enrolment, high absenteeism, early dropout and unsatisfactory classroom performance. The present scenario of health and nutritional status of the school-age children in India is very unsatisfactory (IIPS, 2007). Iron and

Zinc are essential nutrients not only for the normal growth, health, and survival of children but also for their normal mental and motor development and cognitive functioning. Deficiency is associated with significantly poorer performance on psychomotor and mental development scales and behavioral ratings in infants, lower scores on cognitive function tests and lower educational achievement tests in preschool and school age children (Nokes et al., 1998). Food-based approaches aim at improving nutrition by increasing the availability and consumption of a nutritionally adequate and micronutrient rich diet made up from a variety of available foods. Food based approaches are recognised as an essential part of an urgently needed more comprehensive strategy to combat iron and other micronutrient deficiencies (Monika Jain, 2013). So the present study was undertaken to assess the impact of an iron and zinc rich food on the nutrition and cognition of school children.

## **MATERIALS AND METHODS**

The study was conducted among school children in Suler taluk of Coimbatore district. Ninety children with mild anaemia who were of 8 years of age were selected for the study.

Ethical approval was obtained from the Research Ethics Committee (REC) of PSG College of Arts and Science, Coimbatore for the study. Permission to conduct the study in the schools was obtained from the school authorities and informed consent from parents.

An interview schedule was formulated to collect information on nutritional status and cognition of the children. The anthropometric parameters used in the study were height, weight and Body Mass Index. Body weight was measured using Wellcare digital personal

scale (to the nearest 0.1 kg). Height was measured (to the nearest 0.5 cm) with the subject standing in an erect position on a stadiometer platform.

The body mass index (BMI) was computed following the standard formula:  
$$\text{BMI (kg/m}^2\text{)} = \text{Weight (kg)} / \text{Height}^2 \text{(m}^2\text{)}.$$

The haemoglobin levels of the students were determined by using Drabkin's method. The quantitative determination of Ferritin in serum was analysed by means of particle enhanced turbidimetric immunoassay. The determination of Zinc was carried out using Zinc Kit by Coral clinical system using Colorimetric method

A battery of six tests was used to assess the level of cognition among the children selected for the supplementation study. The battery of tests was developed and standardized on Indian children to suit Indian conditions by NIMHANS (Barnabas et al., 2002) (National Institute of Mental Health and Neurological Sciences, Bangalore, India).

### **Tests for Cognition:**

**Personal Information:** This test is a measure of remote memory which constitutes recall of past events of personal life. This is adopted from Wechsler memory scale (1977) and PGI memory scale (1990).

**Digit Span:** This subtest is taken from Wechsler memory scale (1977). This comprises of span for digits forward and backward. The maximum number of digits used in the series is limited to nine. This test is a measure of attention and concentration.

**Mental Control:** This test assess the ability to recollect the verbal automatisms learned by routine in early childhood and frequently used throughout life are normally recalled unthinkingly, effortlessly and accurately.

**Mann-Suiter Visual Memory Screen for Objects:** This is designed to assess the

ability to revisualise pictures of common objects presented in groups. There are four cards. On the first card there are two pictures and it was exposed for two seconds. The second card has three pictures and it was exposed for three seconds, the third card

had four pictures and the fourth card had five pictures and it was exposed for four seconds and five seconds respectively. The child was expected to recall the pictures in the same sequence. This test measures short term visual memory (Mann et al., 1979).

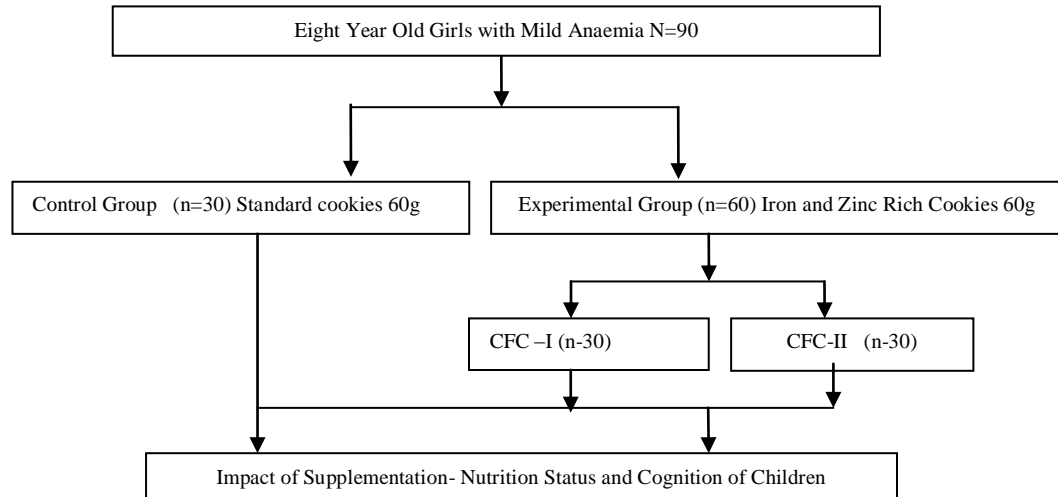


FIG I- EXPERIMENTAL DESIGN

**Benton Visual Retention Test (BVRT):** This test is designed to assess visual perception, Visual memory and visual-constructive abilities. There are 10 cards. Each card is exposed for 10 seconds and the child is asked to reproduce the design from memory. This test measures the visual spatial perception; visual and verbal conceptualization and immediate memory span (Walsh et al., 1990).

**Cattells Retentivity Test:** It consists of complex and unfamiliar designs of irregular geometric figures which cannot elicit any verbal associations. On a card 10 geometrical figures are presented for 30 seconds, after a two minute pause and from the second card the child has to recognize the geometrical figures which he has already seen in the first card. This measures the visual recall for irregular geometrical designs and delayed memory span (Cattell et al., 1948).

Two cookies with iron and zinc rich ingredients were prepared for supplementation by substituting the wheat flour with iron and zinc rich ingredients little millet, sesame, wheat germ, rice flakes and coconut meal. The standard cookie was prepared with 100 g wheat flour. Hundred gram of the standard cookie provided 485 kcal of energy, 4.8g of protein, 6.8 mg of iron and 0.52mg of zinc. The composite flour cookie I and composite cookie II provided 517 kcal and 541kcal of energy, 11.8 g and 8.0g of protein, 15.8 mg and 12.2 mg of iron and 3.5 mg and 4.6 mg of zinc respectively per 100 g. From the 90 children who participated in the study 60 children were given the formulated iron and zinc rich snack. Sixty grams of the cookies was sufficient to bridge the deficit of iron and zinc as evaluated by 24 hour dietary recall method. Thirty children were given the Experimental cookies I (CFC I) and the next 30 children were given Experimental

cookies II (CFC II). The remaining 30 children were kept as the control group for whom the standard cookies were given. The cookies were supplemented for a period of six months. The selected children were given deworming tablets before the start of the study under medical advice and supervision.

## RESULTS

### I. ANTHROPOMETRIC INDICES

The anthropometric parameters of the children were compared with the standard given by ICMR. The mean height of the children who were in CFC I group at the start of the study was 122.46 cm  $\pm$  5.83 which increased to 126.43 cm  $\pm$  5.52. There was increase noted in the weight of the CFC II group from 21.70 kg  $\pm$  2.92 to 25.04 kg  $\pm$  2.94 in the six month period. There was only marginal difference in the anthropometric parameters of Control group children as shown in table I

**Table I: Effect Of Supplementation Of Nutrient Rich Cookies On Anthropometric Parameters**

PARAMETER	ICMR	CFC I		CFC II		CONTROL	
		INITIAL	FINAL	INITIAL	FINAL	INITIAL	FINAL
Height (cm)	129.2	122.46 $\pm$ 5.83	126.43 $\pm$ 5.52	121.66 $\pm$ 4.53	125.45 $\pm$ 4.75	123.82 $\pm$ 3.81	125.9 $\pm$ 3.86
Weight(kg)	25	21.61 $\pm$ 3.59	24.58 $\pm$ 3.60	21.70 $\pm$ 2.92	25.04 $\pm$ 2.94	23.27 $\pm$ 2.71	25.38 $\pm$ 2.76
Body Mass Index	15	14.34 $\pm$ 1.58	15.35 $\pm$ 1.39	14.62 $\pm$ 1.38	15.88 $\pm$ 1.31	15.17 $\pm$ 1.32	16 $\pm$ 1.43

According to a study by Sangeetha and Premakumari (2010) on 150 children who were moderately anemic children were supplemented with either food based or synthetic micronutrients for six months had registered height nearing or above the standard values. Over a period of six months all the children receiving food based supplement recorded a significant increase ( $p < 0.01$ ) in their weight and the children who received tablets as their supplement recorded increments at five per cent level of significance.

**BIOCHEMICAL PARAMETERS:** Iron and zinc are essential micronutrients for human growth, development, and maintenance of the immune system. Iron is needed for psychomotor development, maintenance of physical activity and work capacity, and resistance to infection (*Stoltzfus, 2001*). Zinc is needed for growth and for maintenance of immune function, which enhances both the prevention of and recovery from infectious diseases (*Black, 2003*).

The initial mean ferritin level of the CFC group was 26.57 ng/ml  $\pm$  7.69 and the

final was 32.67 ng/ml  $\pm$  9.11. At the start of the supplementation study the mean haemoglobin level of CFC II was 10.96 g/dl  $\pm$  0.30 which increased to 12.11 g/dl  $\pm$  0.44 at the end of the study. It is seen that the  $p$  value was  $< 0.005$  when the initial and final values were compared for the three biochemical parameters except the ferritin value of the control group.

**Table II: Effect of Supplementation of Nutrient Rich Cookies on the Biochemical Parameters**

Parameter	CFC I	CFC II	CONTROL
<b>Haemoglobin g/dl</b>			
Initial	10.84 $\pm$ 0.686	10.96 $\pm$ 0.30	10.78 $\pm$ 0.36
Final	12.34 $\pm$ 0.64	12.11 $\pm$ 0.44	11.01 $\pm$ 0.37
P value	$< 0.005$	$< 0.005$	$< 0.005$
<b>Ferritin ng/ml</b>			
Initial	26.57 $\pm$ 7.69	33.5 $\pm$ 13.0	29.71 $\pm$ 10.35
Final	32.67 $\pm$ 9.11	40.57 $\pm$ 12.97	32.65 $\pm$ 9.50
T test	$< 0.005$	$< 0.005$	$> 0.005$
<b>Zinc <math>\mu</math>g/dl</b>			
Initial	61.59 $\pm$ 4.38	60.86 $\pm$ 2.91	60.38 $\pm$ 2.72
Final	69.68 $\pm$ 7.13	71.1 $\pm$ 7.09	64.20 $\pm$ 3.36
T test	$< 0.005$	$< 0.005$	$< 0.005$

In a recent study by Angeles-Agdeppa et al., 2011 One hundred randomly selected anemic children were randomly allocated into two groups. Group 1 received the fortified juice and Group 2 received the nonfortified juice for 100 days, five days a

week under strict supervision. The juice drink was fortified with vitamin A, zinc, iron, vitamin C and lysine. The non-fortified juice was fortified only with vitamins. The basal prevalence of anemia was significantly reduced in both the fortified group (100% to 13%) and the non-fortified group (100% to 40%) at endline. The mean plasma ferritin levels were similar in both groups at baseline and endline. At endline, mean plasma zinc in the fortified group has significantly increased by 20 µg/dL from a baseline value of 83.9 µg/dL to 103.9 µg/dL,

while the non-fortified group remained at similar levels with baseline (2011).

## II. IMPACT ON COGNITION

Iron and zinc deficiency is associated with memory deficits in children. There is a marked improvement in memory and concentration after supplementation. Identification of the common micronutrient deficiency at an early age and proper supplementation would prevent derangement in cognitive function in the later age (Chaudhary et al., 2015).

**Table III: Effect of Supplementation of Nutrient Rich Cookies on Cognition Scores**

Cognition	Cfc I			Cfc Ii			Control		
	Initial	Final	P Value	Initial	Final	P Value	Initial	Final	P Value
Personal Information	4.07	4.57	<0.005	3.97	4.55	<0.005	3.6	4.07	<0.005
Digit Span	7.18	9.14	<0.005	7.83	9.69	<0.005	7.57	8.57	>0.005
Mental Control	9.07	10.89	<0.005	7.28	8.97	<0.005	7.67	8.33	>0.005
Mann-Suiter Visual Memory Screen For Objects	3.04	3.54	<0.005	3.07	3.55	<0.005	3.43	3.63	>0.005
Benton Visual Retention Test	5.32	6.82	<0.005	6.03	7	<0.005	6.1	6.93	>0.005
Cattells Retentivity Test	6	7.57	<0.005	5.83	6.97	<0.005	6	6.8	<0.005

There was an increase in all the tests when the initial and final values were compared in all the three groups. There was a significant improvement (P<0.005) in the cognition scores in all the six tests on supplementation of the formulated micronutrient cookies (CFC I and CFC II). However the increase was the highest in CFC II group followed by CFC I group. The increase was less in all the six tests in the control group children.

A study was undertaken by Umamageshwari et al., (2011) to evaluate the effect of iron and zinc deficiency on short term memory of 100 children in the age group of 6-11 years and to assess the response to supplementation therapy. Intervention of Iron (2mg/kg bodyweight in two divided doses) and zinc (5mg once-a-day) supplementation for a period of 3 months for children in the deficient group was given. The results showed that all children with iron and zinc deficiency in both the age groups had memory deficits.

Combined deficiency in 9-11 years group showed severe degree of affectation in verbal (P<0.01) and non-verbal memory (P<0.01), and improved after supplementation (P = 0.05 and P<0.01, respectively). In 6-8 years group, only non-verbal form of memory (P =0.02) was affected, which improved after supplementation.

## CONCLUSION

The supplementation of the iron and zinc rich cookies improved the anthropometric and biochemical parameters of the selected school children. The cognition scored also increased after the supplementation. Use of locally available nutrient rich foods can be used as an effective tool in combating nutrition deficiencies.

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