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Effect of Micronutrient Fortified Biscuit Supplementation on the Weight, Height and BMI of Adolescent Girls

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A B S T R A C T

A study was designed to determine the effect of supplementation of biscuits with and without micronutrients on the weight and height of adolescent girls (N=107) in the age group of 10 to 16 years studying in a government school in Jaipur city. Data on weights and heights were collected using standardized techniques. Hundred grams of biscuits furnishing 497 kcal and 11.36 g of protein per day for all working days in a 4 month period was provided to the control group (N=54); and 100 g of biscuits fortified with one RDA levels of vitamin A, iron, folic acid, vitamin C and iodine was provided to the experimental group (N=53). Supplementation with biscuits resulted in significant weight gains of 1.85 kg and 2.00 kg in the control and experimental groups, respectively. As per weight for age, the increments in the normal category was from 27.8% to 40.7% in adolescent girls of the control group and from 34.0% to 45.3% in those of the experimental group. There was statistically significant improvement in the mean BMI, as well as in various grades of chronic energy deficiency, after intervention. In conclusion, intervention with biscuits with and without nutrients resulted in significant improvements in weight gain and BMI.

Key words: *Supplementation, biscuits, weight, height, BMI, girls, Jaipur city*

Introduction

Malnutrition is still rampant in the under-privileged sections of populations in India. Children and adolescent girls living in slums have poor nutritional status. Attempts have been made in the past to use nutrient fortified food products to ameliorate their nutritional status[1–3].

van Stuijvenberg[4] has advocated that school feeding can be used as a vehicle for food supplementation and micronutrient fortification. Even, Gopalan[5] had earlier suggested using the school system as the 'second front' for improving the health and nutrition status of the population.

Biscuit can be used as a vehicle for fortification because it is seen as a snack rather than a meal and therefore, unlikely to replace meals given to the child at home. Additional advantages of using biscuits are that it needs no preparation, is easy to distribute and has long shelf life. It is also easy to monitor and therefore, less open to misuse and corruption[6].

Adolescent girls are a marginalized group in any society more so when they belong to the low socio economic group and come from slums. The present study was designed to be an intervention study where biscuits fortified with nutrients as vitamin A, iron, folic acid, vitamin C and iodine were used to supplement the diet of adolescent girls attending a government school. The girls suffer from malnutrition and have multiple micronutrient deficiencies; hence, this study was an attempt to ameliorate their nutritional status.

Materials and Methods

Study area and subjects

A government school where the number of girls enrolled was high and the school being close to the University of Rajasthan, Jaipur, Rajasthan, India for logistical convenience was selected for the study. The adolescent girls resided in a slum where the school was located and had quite similar socio-economic background. All adolescent girls studying in classes VI to VIII were enrolled for

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the study thus formulating the entire population. Based on their ages, the girls were classified into age groups between 10 to16 years. There was comparatively lesser number of girls in the older age group. Data of adolescent girls (n=107) available for pre and post intervention, were included. The girls were randomly allocated to the control and experimental groups.

Anthropometric measurements and evaluation of nutritional status

The weight of the girls was measured using a standardized bathroom weighing balance. The subjects were asked to remove footwear and other winter clothing in winters for weight measurement. The body weight was recorded when the display of the body weight became stabilized. For measuring standing height, vertical anthropometric rod with a movable head board was used. The height was recorded to the nearest centimeter using a standardized procedure. BMI (Body Mass Index) of the girls was calculated with the help of a formula: weight in kg/height in m^2. The weights and heights of the adolescent girls were compared with NCHS standards[7] according to their ages. The subjects were categorized as *per* Indian Academy of Pediatrics classification using weight for age and Vishveshwara Rao's classification using height for age as indicators[8]. On the basis of BMI, the girls were classified into various categories of chronic energy deficiency based on the classification cited by Reddy et al.[9] for adults. Further classification of adolescent girls on the basis of BMI for age (5–19 years) Z scores[10] was carried out.

Supplementation

Biscuits were prepared with 35 g wheat flour whole, 15 g soybean flour, 30 g sugar, 20 g of hydrogenated vegetable fat and 20 mL of milk. The biscuits provided 497 kcal and 11.36 g of protein. Hundred grams of biscuits were provided to the control group (n=54); and 100 g of biscuits fortified with synthetic micronutrients: vitamin A (600 mcg), iron (30 mg), folic acid (100 mcg), vitamin C (40 mg) and iodine (150 mcg) at one RDA levels were provided to the experimental group (n=53). The biscuits were sent to Food Research and Analysis Center, Federation House, Tansen Marg, New Delhi for determining the losses of nutrients on baking. The biscuits were prepared with added nutrients taking losses into consideration.

Biscuit distribution commenced from 1st September 2004 and continued till 18th December 2004 for all work-

TABLE 1
EFFECT OF SUPPLEMENTATION ON WEIGHT AND HEIGHT OF ADOLESCENT GIRLS

	Pre-Intervention		Post-intervention		Change		% Change		paired t test value	
	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight (kg)	Height (cm)	Weight	Height	Pre *vs*. Post Weight	Pre *vs*. Post Height
Total Sample										
Control	32.53	143.34	34.38	144.05	1.85	0.71	5.7	0.5	11.754*	5.933*
(N=54)	±6.53	±8.31	±6.38	±7.83						
Experimental	34.47	145.16	36.47	145.83	2.00	0.67	5.8	0.5	12.561*	3.559*
(N=53)	±5.71	±7.60	±5.60	±6.83						
Control										
10^+–11^+ years	28.2	137.1	30.0	138.3	1.8	1.2	6.4	0.9	10.122*	7.546*
(N=16)	±4.8	±9.1	±4.8	±8.8						
12^+–13^+ years	33.0	145.0	34.9	145.5	1.9	0.5	5.8	0.3	7.664*	3.054*
(N=30)	±5.5	±6.8	±5.0	±6.3						
14^+–16^+ years	39.4	149.6	41.0	150.0	1.6	0.4	4.1	0.3	5.406*	2.433*
(N=8)	±7.1	±2.9	±7.7	±2.9						
Experimental										
10^+–11^+ years	29.8	139.7	32.1	141.4	2.3	1.7	7.7	1.2	7.183*	5.530*
(N=13)	±5.1	±7.6	±4.9	±6.7						
12^+–13^+ years	35.8	147.2	37.8	147.8	2.0	0.6	5.6	0.4	8.738*	2.135*
(N=27)	±5.0	±7.7	±5.1	±7.1						
14^+–16^+ years	36.4	146.2	38.0	146.3	1.6	0.1	4.4	0.1	5.826*	0.951 NS
(N=13)	±5.5	±4.4	±5.4	±4.4						

$\overline{X}$±SD
Figures in parentheses denote percentages
*Significant at 5% level of significance
NS – Non–significant

ing days. Considering the holidays during this period, the biscuits were distributed for a total of 75 days in these four months. The mean attendance of the girls was 76.5±15.56 percent. The school had closed for winter vacations from 23rd December 2004, hence post intervention data were collected in January 2005. Pre intervention data were collected in the month of August 2004. Prior to intervention the adolescent girls were dewormed with 400mg of albendazole. The subjects were asked to take the tablets in the school in front of the investigator. The biscuits were distributed in the last two periods in the school in front of the investigator and it was ensured that the biscuits were consumed by the girls. The school administration was very cooperative as they understood that the project would ultimately benefit their students.

Ethics

The study was approved by the Departmental Ethics Committee and an informed consent was obtained from the parents of the students for participation in the study.

Statistical analysis

The pre and post intervention data were analyzed for significant differences using paired t-test[11].

Results

Effect of supplementation on the weight and height

The mean weights and heights of control and experimental subjects at pre and post intervention are presented in Table 1. It was observed that the control group had gained 1.85 kg and the experimental group had gained 2.00 kg on intervention. The experimental group had gained 150 g more weight than the control group. The gain in height was about 0.7 cm by the control and experimental groups. Considering the percent change in weight, it was 5.7% in the control group and 5.8% in the experimental group. With regards to height it was 0.5% each in the control and experimental groups. The increments in weights and heights observed in the control and experimental groups were found to be significant. Almost similar weight and height gain was observed for both the control and experimental groups because both the groups had received supplementation in the form of biscuits. Slight additional benefit in weight gain was seen with the addition of micronutrients to biscuits.

Looking at the data age-wise, higher weight and height gain was observed in the lower age groups of 10^+ to 11^+ years and 12^+ to 13^+ years as compared to the older age group of 14^+ to 16^+ years; moreover, these increments were significant at 5% level of significance.

Effect of supplementation on the extent of malnutrition

Weight for age – control group

In the control group, there was an increase of 7 subjects in the normal category at post intervention (Table 2). There was a decrease from 2 to 1 subject in Grade IV category of malnutrition. This one subject had shifted from Grade IV to Grade III of malnutrition, 5 girls had shifted from Grade III to Grade II, one girl from Grade II to Grade I, and 7 girls from Grade I to normal category, after intervention. Age-wise data had also shown improvements in various grades of malnutrition.

TABLE 2
EFFECT OF SUPPLEMENTATION ON EXTENT OF MALNUTRITION IN CONTROL GROUP OF ADOLESCENT GIRLS

Control	Pre-intervention				Post-intervention			
	10^+–11^+ years	12^+–13^+ years	14^+–16^+ years	Total	10^+–11^+ years	12^+–13^+ years	14^+–16^+ years	Total
	(N=16)	(N=30)	(N=8)	(N=54)	(N=16)	(N=30)	(N=8)	(N=54)
Weight for Age[a]								
>80% Weight for Age (Normal)	5 (31.3)	8 (26.7)	2 (25.0)	15 (27.8)	7 (43.8)	12 (40.0)	3 (37.5)	22 (40.7)
71–80% Weight for Age (Grade I)	4 (25.0)	11 (36.7)	1 (12.5)	16 (29.6)	3 (18.8)	7 (23.3)	0 (0.0)	10 (18.5)
61–70% Weight for Age (Grade II)	4 (25.0)	5 (16.7)	3 (37.5)	12 (22.2)	3 (18.8)	9 (30.0)	4 (50.0)	16 (29.6)
51–60% Weight for Age (Grade III)	3 (18.8)	4 (13.3)	2 (25.0)	9 (16.7)	3 (18.8)	1 (3.3)	1 (12.5)	5 (9.3)
<50% Weight for Age (Grade IV)	0 (0.0)	2 (6.7)	0 (0.0)	2 (3.7)	0 (0.0)	1 (3.3)	0 (0.0)	1 (1.9)
Height for Age[b]								
91–100% Height for Age (Normal)	8 (50.0)	18 (60.0)	5 (62.5)	31 (57.4)	8 (50.0)	19 (63.3)	5 (62.5)	32 (59.3)
80–90% Height for Age (Mild retardation)	8 (50.0)	12 (40.0)	3 (37.5)	23 (42.6)	8 (50.0)	11 (36.7)	3 (37.5)	22 (40.7)
<80% Height for Age (Poor)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0

Figures in parentheses denote percentages
[a] Indian Academy of Pediatrics Classification
[b] Vishveshwara Rao's Classification

TABLE 3
EFFECT OF SUPPLEMENTATION ON EXTENT OF MALNUTRITION IN EXPERIMENTAL GROUP OF ADOLESCENT GIRLS

Experimental	Pre-intervention				Post-intervention			
	10^+–11^+ years	12^+–13^+ years	14^+–16^+ years	Total	10^+–11^+ years	12^+–13^+ years	14^+–16^+ years	Total
	(N=13)	(N=27)	(N=13)	(N=53)	(N=13)	(N=27)	(N=13)	(N=53)
Weight for Age[a]								
>80% Weight for Age (Normal)	8 (61.5)	9 (33.3)	1 (7.7)	18 (34.0)	8 (61.5)	15 (55.6)	1 (7.7)	24 (45.3)
71–80% Weight for Age (Grade I)	2 (15.4)	13 (48.1)	2 (15.4)	17 (32.1)	2 (15.4)	7 (25.9)	4 (30.8)	13 (24.5)
61–70% Weight for Age (Grade II)	2 (15.4)	2 (7.4)	7 (53.8)	11 (20.8)	2 (15.4)	3 (11.1)	7 (53.9)	12 (22.6)
51–60% Weight for Age (Grade III)	1 (7.7)	3 (11.1)	3 (23.1)	7 (13.2)	1 (7.7)	2 (7.4)	1 (7.7)	4 (7.6)
<50% Weight for Age (Grade IV)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Height for Age[b]								
91–100% Height for Age (Normal)	12 (92.3)	20 (74.1)	6 (46.1)	38 (71.7)	12 (92.3)	22 (81.5)	6 (46.1)	40 (75.5)
80–90% Height for Age (Mild retardation)	1 (7.7)	7 (25.9)	7 (53.9)	15 (28.3)	1 (7.7)	5 (18.5)	7 (53.9)	13 (24.5)
<80% Height for Age (Poor)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

Figures in parentheses denote percentages
[a] Indian Academy of Pediatrics Classification
[b] Vishveshwara Rao's Classification

Weight for age – experimental group

Changes in extent of malnutrition were observed in the experimental group as were observed in the control group. In the normal category there was an increase of 6 subjects, and a decrease of 3 subjects in Grade III of malnutrition (Table 3). There was a shift of 3 subjects from Grade III to Grade II, 2 subjects from Grade II to Grade I and of 6 subjects from Grade I to normal category. Improvements in various categories of malnutrition were observed in the ages of 12^+ to 13^+ years and 14^+ to 16^+ years.

Height for age – Control and Experimental groups

In the control group, there was an increase of one subject in the normal category due to a shift of one subject from mild retardation (Table 2) while a shift of 2 subjects to the normal category was observed in the experimental group (Table 3).

In the control group, the percentage of adolescent girls in the normal category had increased from 27.8% to 40.7% and the percentage of adolescent girls in the Grade I of malnutrition had decreased from 29.6% to 18.5% (Figure 1). In the experimental group, this trend was also

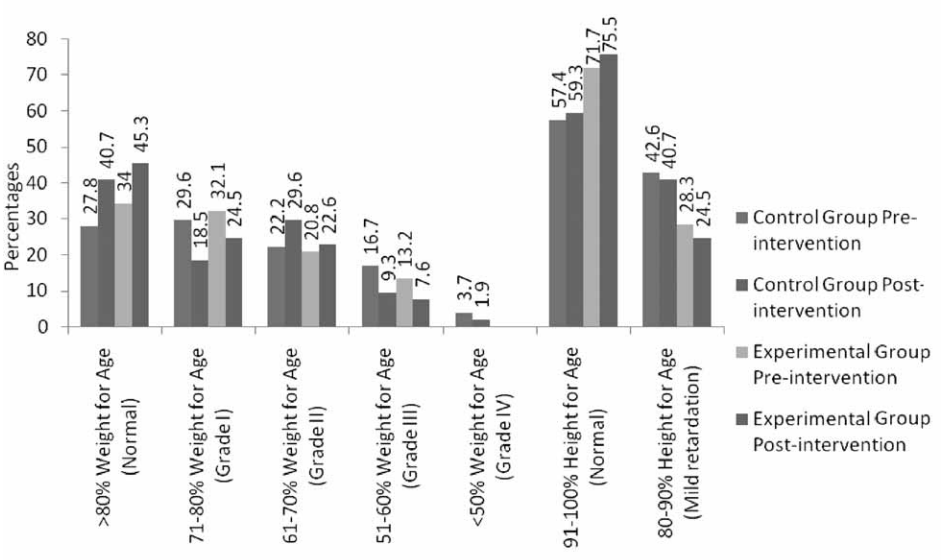

Fig. 1. Extent of malnutrition in control and experimental groups at pre and post intervention.

evident with an increase from 34.0% to 45.3% in the normal category and a decrease from 32.1% to 24.5% in the Grade I of malnutrition (Figure 1). Due to upward movement of adolescent girls from Grade IV of malnutrition to normal category, better picture emerged at various grades of malnutrition after supplementation.

Effect of supplementation on the BMI of subjects at post intervention

Significant increases in BMI were observed in all age groups of control and experimental subjects (Table 4), thereby, implying that intervention with biscuits with and without micronutrients was effective in improving the nutritional status of the adolescent girls. Furthermore, after intervention, decreases were noted in the percentage of adolescent girls falling in the severe category of chronic energy deficiency. In the control group, this decrease was from 63.0% to 42.6% and it was from 41.5% to 32.1% in the experimental group. There was a shift of girls from the severe to moderate, from moderate to mild and from mild to normal categories of chronic energy deficiency both in the control and experimental groups. Such beneficial changes were observed in all age groups.

Effect of supplementation on the BMI for age of subjects at post intervention

It is evident from Table 5 that at pre intervention, majority of adolescent girls were in the –2SD to –1SD category of malnutrition while at post intervention, most of the girls could be located in –1SD to Median category in both the control and experimental groups. However, better improvements were noted for the experimental group. In all age groups, also, such amelioration in nutritional status was observed.

The data on extent of malnutrition suggested that there were definitive improvements in the anthropometric profile of the subjects on intervention with 100 g of biscuits with and without micronutrients. It is, therefore, recommended that schools can be used as a plat-

TABLE 4
EFFECT OF SUPPLEMENTATION ON BMI OF ADOLESCENT GIRLS

	Preintervention						Postintervention						
	BMI Classification						BMI Classification						
	BMI	<16	16.0–17.0	17.0–18.5	18.5–20.0	20.0–30.0	BMI	<16	16.0–17.0	17.0–18.5	18.5–20.0	20.0–30.0	paired t-test value
		CED Grade III	CED Grade II	CED Grade I	Low weight	Normal		CED Grade III	CED Grade II	CED Grade I	Low weight	Normal	
		(Severe)	(Moderate)	(Mild)	(Normal)			(Severe)	(Moderate)	(Mild)	(Normal)		
Total Sample													
Control	15.7	34 (63.0)	7 (13.0)	8 (14.8)	4 (7.4)	1 (1.8)	16.5	23 (42.6)	12 (22.2)	12 (22.2)	5 (9.3)	2 (3.7)	10.131*
(N=54)	±2.1						±2.1						
Experimental	16.3	22 (41.5)	13 (24.5)	15 (28.3)	2 (3.8)	1 (1.9)	17.1	17 (32.1)	8 (15.1)	19 (35.8)	8 (15.1)	1 (1.9)	10.484*
(N=53)	±1.8						±1.8						
Control													
10^{+}–11^{+} years	14.9	13 (81.3)	1 (6.3)	2 (12.5)	0 (0.0)	0 (0.0)	15.6	10 (62.5)	3 (18.8)	3 (18.8)	0 (0.0)	0 (0.0)	6.238*
(N=16)	±1.4						±1.4						
12^{+}–13^{+} years	15.6	18 (60.0)	4 (13.3)	6 (20.0)	2 (6.7)	0 (0.0)	16.4	11 (36.7)	6 (20.0)	9 (30.0)	3 (10.0)	1 (3.3)	7.099*
(N=30)	±2.0						±1.8						
14^{+}–16^{+} years	17.6	3 (37.5)	2 (25.0)	0 (0.0)	2 (25.0)	1 (12.5)	18.2	2 (25.0)	3 (37.5)	0 (0.0)	2 (25.0)	1 (12.5)	4.781*
(N=8)	±2.9						±3.1						
Experimental													
10^{+}–11^{+} years	15.2	9 (69.2)	2 (15.4)	2 (15.4)	0 (0.0)	0 (0.0)	16.0	7 (53.9)	3 (23.1)	3 (23.1)	0 (0.0)	0 (0.0)	4.672*
(N=13)	±1.6						±1.5						
12^{+}–13^{+} years	16.4	9 (33.3)	7 (25.9)	10 (37.0)	1 (3.7)	0 (0.0)	17.3	7 (25.9)	4 (14.8)	10 (37.0)	6 (22.2)	0 (0.0)	7.399*
(N=27)	±1.4						±1.6						
14^{+}–16^{+} years	17.0	4 (30.8)	4 (30.8)	3 (23.1)	1 (7.7)	1 (7.7)	17.8	3 (23.1)	1 (7.7)	6 (46.2)	2 (15.4)	1 (7.7)	5.587*
(N=13)	±2.2						±2.2						

$\overline{X}$±SD
Figures in parentheses denote percentages
*Significant at 5% level of significance

TABLE 5
EFFECT OF SUPPLEMENTATION ON BMI FOR AGE OF ADOLESCENT GIRLS

	Preintervention					Postintervention				
	BMI Z scores					BMI Z scores				
	< –3SD	–3SD to –2SD	–2SD to –1SD	–1SD to Median	Median to +1SD	< –3SD	–3SD to –2SD	–2SD to –1SD	–1SD to Median	Median to +1SD
Total Sample										
Control (N=54)	5 (9.3)	11 (20.4)	20 (37.0)	16 (29.6)	2 (3.7)	2 (3.7)	6 (11.1)	19 (35.2)	22 (40.7)	5 (9.3)
Experimental (N=53)	2 (3.8)	8 (15.1)	21 (39.6)	20 (37.7)	2 (3.8)	0 (0.0)	8 (15.1)	15 (28.3)	23 (43.4)	7 (13.2)
Control										
10^{+}–11^{+} years (N=16)	1 (6.3)	3 (18.8)	7 (43.8)	4 (25.0)	1 (6.3)	0 (0.0)	2 (12.5)	6 (37.5)	6 (37.5)	2 (12.5)
12^{+}–13^{+} years (N=30)	4 (13.3)	4 (13.3)	12 (40.0)	10 (33.3)	0 (0.0)	2 (6.7)	3 (10.0)	9 (30.0)	14 (46.7)	2 (6.7)
14^{+}–16^{+} years (N=8)	0 (0.0)	4 (50.0)	1 (12.5)	2 (25.0)	1 (12.5)	0 (0.0)	1 (12.5)	4 (50.0)	2 (25.0)	1 (12.5)
Experimental										
10^{+}–11^{+} years (N=13)	1 (7.7)	1 (7.7)	5 (38.5)	6 (46.2)	0 (0.0)	0 (0.0)	2 (15.4)	3 (23.1)	7 (53.9)	1 (7.7)
12^{+}–13^{+} years (N=27)	1 (3.7)	4 (14.8)	9 (33.3)	12 (44.4)	1 (3.7)	0 (0.0)	3 (11.1)	8 (29.6)	11 (40.7)	5 (18.5)
14^{+}–16^{+} years (N=13)	0 (0.0)	3 (23.1)	7 (53.8)	2 (15.4)	1 (7.7)	0 (0.0)	3 (23.1)	4 (30.8)	5 (38.5)	1 (7.7)

Figures in parentheses denote percentages

form for distribution of food products fortified with nutrients to augment the nutritional status of school going children.

Discussion

Vinod Kumar and Rajagopalan[12] had assessed the impact of multiple micronutrient food supplements on the nutritional status of school children (5–15 years) from residential schools in the city of Chennai, India. The dosage was 1 g of supplement *per* child *per* day which was given for a period of 9 months to the experimental group (n=211). There was no nutritional intervention in the control group (n=202). The increments in weight were to the tune of 1.82 kg and 1.65 kg in the experimental and control groups; and in height it was 3.53 cm and 2.93 cm, respectively.

Jood et al.[1] studied the effect of supplementation on nutritional status of 66 school children of 10–12 years of age from Hisar, India for a period of 4 months. Hundred grams of cauliflower leaves powder supplements i.e. biscuits and *shakarpara* were fed to 33 deficient subjects. Increases of 4.48 and 7.06% in weight and height were observed, respectively. Initially, 27.27% children had normal nutritional status in deficient group, but after supplementation, this value had increased to 42.42%. In the present study, increases of 5.7% and 5.8% in weight of adolescent girls were observed in the control and experimental groups after biscuits with and without nutrients were fed to the adolescent girls for about 4 months. The percentage gain in height was below 1% in both the groups. Furthermore, the percentage of adolescent girls in the normal category had increased from 27.8% to 40.7% and from 34.0% to 45.3% in the control and experimental groups, respectively. In both the studies, the nutrients were provided through a 'food' vehicle i.e. biscuits/*shakarpara* and had shown beneficial effects.

Sarma et al.[3] had evaluated the effect of a micronutrient fortified beverage on growth in healthy school children from Hyderabad, India (n=446, 6–16 years). After 14 months of supplementation, significant increases in mean increments of height and weight Z scores were observed. Similarly, in a randomized double blind placebo controlled trial, a dietary supplement in the form of a fortified powder fruit drink produced statistically significant difference in the growth of young school age children from Ithaca, USA[2].

The effect of a package of health inputs including anthelmintics and micronutrient supplementation of iron and vitamin A and iodine fortified salt added to the school meals on school children from Gujarat, India was determined by Gopaldas[13]. The students who received the supplement were 1.1 kg heavier and 1.1 cm taller than those who did not receive the supplement.

Kanani and Poojara[14] investigated the effect of iron folic acid supplements for 3 months on growth in adoles-

cent girls 10–18 years of age from Baroda, India. A significant weight gain of 0.83±0.09 kg was seen in the intervention group. Mann et al.[15] gave iron and energy supplementation for 3 months to 15 female college students aged 16–20 years who were iron and energy deficient. A significant ($p<0.01$) increase in weight, body mass index, mid-upper arm circumference, and body fat were observed. In the present study, too, significant increases in body weight of the subjects of both experimental and control groups were observed as a result of biscuit supplementation with and without micronutrients.

A few studies conducted on infants[16], preschool and school children[17–22] and adolescent girls[23] have also shown beneficial effects of iron and/or vitamin A supplementation on growth.

It can, therefore, be concluded that dietary supplementation helps to improve the nutritional status of children and adolescent girls. Hence, efforts are needed to use the school system favorably for improving their nutritional status.

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UTJECAJ UZIMANJA KEKSA OBOGAĆENIH MIKRONUTRIJENTIMA NA TEŽINU, VISINU I INDEKS TJELESNE MASE KOD ADOLESCENTICA

SAŽETAK

Studija je provedena kako bi se utvrdio utjecaj dodataka hrani u obliku keksa sa i bez mikronutrijenata na težinu i visinu adolescentica (N=107), dobne skupine od 10 do 16 godina, u državnoj školi u Jaipuru. Podaci o težini i visini su prikupljeni standardiziranim metodama. Kontrolna skupina (N=54) je svaki radni dan u periodu od četiri mjeseca dobivala 100 g keksa energetske vrijednosti 497 kcal i 11,36 g proteina, dok je eksperimentalna skupina (N=53) svakodnevno uzimala 100 g keksa obogaćenih vitaminom A, željezom, folnom kiselinom, vitaminom C i jodom. Dodatak prehrani u obliku navedenih keksa znatno je utjecao na porast težine u rasponu od 1,85 do 2 kg u obje skupine. S obzirom na godine, povećanje težine je iznosilo od 27,8% do 40,7% u kontrolnoj skupini i od 34,0% do 45,3% u eksperimentalnoj skupini. Utvrđen je također i statistički značajan porast indeksa tjelesne mase. Zaključno možemo utvrditi da intervencija s keksima sa i bez nutrijenata značajno utječe na porast težine i indeks tjelesne mase.