

## **IMPACT OF DIFFERENT INTERVENTION STRATEGIES ON SELECTED OBESE CHILDREN OF COIMBATORE CITY**

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### **Introduction**

The major nutrition issues among children and adolescents have shifted from nutrient deficiency diseases, common in the first half of the 20th century, to concerns today about over consumption, poor dietary quality and poor food choices. Among the nutritional problems, obesity is now reaching epidemic proportions in both developed and developing countries and is affecting not only adults but also children and adolescents<sup>1</sup>. Even in countries like India, a significant proportion of overweight and obese children now coexist with those who are under nourished. As a result of rapid socioeconomic advancements in the recent decades, the population is undergoing significant lifestyle changes, including changes in dietary and meal patterns, such as increased consumption of fats and oils, decreased intake of complex carbohydrates, eating out and skipping meals.

Obesity is a multifactor disorder and its development is due to multiple interactions between genes and environment. The primary cause for being overweight and obese is unlimited access to food, reduction in physical activity as well as the fulfilment of the genetic responses that the body stores

up fat reserves during times of abundance for 'leaner' periods later on<sup>2,3</sup>. Childhood obesity is partly due to genetic components and due to environmental factors such as life style, socio economic factors and nutritional habits of the family<sup>4</sup>. Childhood obesity prevention and treatment strategies should include individual treatment goals and approaches based on the child's age, stage of growth and development, degree of overweight and presence of other comorbidities. Dietary fiber has important health benefits in childhood and adolescence. Fiber intake is inversely associated with body weight and body fat and it also promotes regular bowel habits and reduces a child's risk of chronic diseases. It may be useful in preventing and treating obesity and also in lowering blood cholesterol level, both of which may help reduce the risk of future cardiovascular diseases<sup>5</sup>.

Close monitoring of overweight and obesity prevalence in children and taking timely preventive measures will be an effective approach in dealing with the problem of obesity. With this in view, the present study was carried out to develop and implement intervention strategies namely nutrition education, physical activity and snack substitution on selected obese children

and evaluate the impact of the different intervention strategies.

## **Materials and Methods**

### ***Selection of obese children***

Four schools from different areas of Coimbatore city were selected to implement the different intervention strategies. Children and families who were keen, very co-operative and motivated to lose weight were selected. Necessary permission was obtained from the parents of the selected children and the school authorities for including them in the study. A total of 240 obese children (120 boys and 120 girls) were selected by purposive sampling method and they were further divided into three experimental groups and one control group of 60 each as follows :

- Group A (60) : Nutrition Education
- Group B (60) : Nutrition Education and Physical Activity
- Group C (60) : Nutrition Education, Physical Activity and Snack Substitution
- Group D (60) : Control with no Intervention

### ***Determination of body fat percentage***

The initial height and weight of the selected obese children of all the groups were recorded using standard techniques and their Body Mass Index (BMI) was calculated before the conduct of the intervention study. Body fat percentage refers to the percentage of body fat mass in relation to body weight. The weight that is not fat is referred to as the fat free body mass. Tissues containing much water such as muscles,

blood vessels and bones are highly conductive with electricity, but fat tissues are not so. Therefore, by using this principle, it is possible to determine the ratio of fat tissue compared to other tissues in the body.

Bio-electrical Impedance Analysis (BIA) using a small portable fat analyzing instrument or scale which is a non-invasive, safe, cheap and reliable estimation of body composition was used in this study to determine body fat. This method is more convenient and quicker to administer along with anthropometric measurements than any other methods<sup>6</sup>.

For measuring the body fat percentage of the children, data on their heights, weights and age of the children were given as input into the fat analyzer. The children were instructed to stand erect and hold the fat analyzer with their hands stretched (away from their body) at the chest level. The fat percentage was recorded with minimum clothing and accessories. From the electrical conductivity between both hands of the children, the fat percentage digitally displayed by the instrument was recorded.

### ***Development and Implementation of intervention strategies***

#### **Development of nutrition education materials**

Nutrition education materials on aspects like general health and nutrition, importance of balanced diet, causes and consequences of obesity, hazards of consuming junk foods, consuming foods during television viewing and importance of physical activity were developed for effective nutrition education.

A computer assisted instruction tool on obesity management was developed using HTML, Adobe Photoshop, Java Script and MS Flash package with the help of software professional. A pamphlet on energy balance, food pyramid, foods to be avoided and included for obesity prevention was developed for distribution to obese children and their parents. A booklet on obesity management among children was also developed for this purpose and given to the mothers to help them to modify their child's diet at home.

#### **Conduct of nutrition education**

Nutrition education was conducted to parents and obese children on childhood obesity and associated problems and management of childhood obesity. Education was also given on the importance of eating a balanced diet, how to make right and healthy food choices based on the food guide pyramid and the detrimental health effects of fast foods and other energy dense snacks and carbonated beverages. Importance of physical activity for weight reduction and weight maintenance were the other important topics included for nutrition education.

Booklet, pamphlet and handouts with relevant nutrition information developed by the investigator on obesity management were given to mothers of selected children along with sample diet/ menu pattern for weight reduction. Apart from this planned programme, nutrition education was also imparted by using the same teaching aids for normal children and their teachers in a few schools as requested by the school authorities.

#### **Conduct of physical activity programme**

A package of outdoor games which included circle kho-kho, Indian Club Up and Down Relay, Go home, Shadow game along with exercises which included warm up exercises like toe jumping, rotations like neck, shoulder, arm, wrist, hip, knee and ankle, stretching exercises like forward bending, backward bending, side stretching, arm stretching and leg stretching was formulated as physical activity programme in consultation with doctors and physical fitness instructors. Obese children in groups B and C were asked to do physical exercises using the package of outdoor games developed for duration of 40 minutes daily with the help of physical education teachers in the school play ground for a period of four months. Children were also instructed to do the physical exercises at home during holidays under the supervision of their parents.

#### **Development of low calorie, low fat and high fibre snack**

A low calorie, low fat and high fibre diet is recommended for weight loss<sup>7</sup>. Dietary fiber has important health benefits in childhood and adolescence, especially in promoting regular bowel habits and reducing the risk of chronic diseases such as cardiovascular disease, cancer and diabetes mellitus in adulthood<sup>8</sup>.

A millet varagu (*Paspalum scrobiculatum*), a legume horsegram (*Dolichos biflorus*) and curry leaves (*Murraya koenigii*) were selected for developing the snack. Varagu and horsegram were selected because of their high fibre content of 9g and

11g/100g respectively. Curry leaves is a good source of calcium (830mg/100g) and fibre(6.4g). Varagu and horse gram were cleaned, roasted and powdered. Curry leaves were washed thoroughly, shade dried and powdered. All the ingredients namely varagu flour, horse gram flour and curry leaves powder were mixed thoroughly. Sliced onion, green chillies, chopped coriander leaves, salt and water were added and mixed to a dough consistency. The mixture was made into medium sized balls and pressed with the palm to make kozhukattai (a steamed cereal based preparation of Tamilnadu) and steamed for 15 minutes and served hot. The kozhukattai was prepared with different proportions of the selected ingredients and three proportions were found to be satisfactory. The three different formulations are presented in Table I.

Acceptability testing of the three formulations S1, S2 and S3 was conducted and based on the acceptability scores, snack S2 obtaining the highest score of 23.2 out of 25, with the proportion of 45g varagu flour, 30g horse gram flour, 10g curry leaves powder and 15g onion was selected for substitution.

**TABLE I**  
**Proportion of Ingredients in the Snacks**

Ingredients (g)	S1	S2	S3
Varagu flour	55.0	45.0	37.5
Horse gram flour	20.0	30.0	37.5
Curry leaves powder	10.0	10.0	10.0
Onion	15.0	15.0	15.0
Total	100	100	100

### ***Nutrient analysis of the developed snack***

The developed snack was analysed for its nutrient content following the procedures suggested by NIN<sup>9</sup>. The carbohydrate content was estimated by anthrone method, protein content was assessed through macrokjeldahl method. Fat content of the developed snack was estimated by soxhlet method and the energy value was calculated from these proximate principles. The iron content of the developed snack was estimated colorimetrically and calcium was found out using the titrimetric method. Crude fibre and dietary fibre of the developed snack were also estimated using standard procedures<sup>10</sup>.

### ***Conduct of the substitution study***

One serving of 50g of the developed low calorie, low fat and high fibre snack in the form of two kozhukattais (each weighing 25g) was given to 60 obese children (30 boys and 30 girls) in the experimental group C as an evening snack, for a period of four months during working days. Evening snack was the meal preferred for substitution since most of the children ate a calorie dense fried item at home in the evenings. The snack was prepared in the school kitchen and distributed at the school premises daily in mid evening. The children were asked to consume the snack without spilling or wasting. Dry ingredients of the different foods were given to the mothers of the obese children and they were requested to prepare the snacks and give to the children during weekends. The details of the substitution study were presented before an Ethical Committee constituted by the University and were approved by the

Committee members with the approval number HEC.2007.07. The selected obese children were closely monitored and the intervention strategies was evaluated after a period of four months by recording the change in height, weight, BMI and body fat of the children in groups A,B,C and the control group D.

## Results and Discussion

### ***Nutrient content of the developed snack***

The energy value of the snack was found to be 252 Kcal per 100g. The snack contained 11g of protein and 50.1g of carbohydrate and the fat content was found to be only 0.8g in 100g. The calcium content was 235mg and the iron content was 8.3mg per cent. The developed snack contained 9g of crude fibre and 12.8g of dietary fibre in 100g. The serving size of the snack was 50g and the nutrient content changed accordingly (Table II).

### ***Cost of the formulated snack***

The cost of the formulated snack was calculated based on the market prices prevalent in Coimbatore as on July 2009. The cost of the developed snack was Rs. 3.18 per 100g and per serving (50g) was Rs. 1.59.

### ***Effect of intervention strategies on obese children***

The selected obese children were closely monitored and the intervention strategies was evaluated after a period of four months by recording the change in height, weight, BMI and body fat of the children in groups A,B,C and control group D.

**TABLE II**  
**Nutrient Content of the Developed Snack**

Nutrients	Per 100g	Per serving (50g)
Energy (kcal)	252	126
Carbohydrate(g)	50.1	25.2
Protein(g)	11	5.5
Fat(g)	0.8	0.4
Crude fibre(g)	9	4.5
Dietary fibre(g)	12.8	6.4
Calcium(mg)	235	117.5
Iron(mg)	8.3	4.2
Moisture(%)	25.0	12.5

### **Anthropometric measurements**

The anthropometric measurements of obese boys before and after intervention are shown in Table III. The mean height of obese boys in experimental groups A,B and C increased from an initial value of 149.9,150.8 and 149.7cm to 152.3, 153.4 and 152.1 cm respectively after intervention. The mean height of the obese boys in control group D was 148.2 cm before intervention which increased to 150.8 cm after intervention. The increase in the mean height among all the groups were in the range of 2.4 to 2.6cm and was found to be significant ( $p<0.01$ ). This observation may be attributed to the growth spurt among the children irrespective of intervention or not.

The mean weight of obese boys in experimental groups A, B and C respectively was found to be 56.1, 55.3 and 53.4 kg at the start of the intervention strategies which got reduced to 55.1, 54.1 and 52.0 kg respectively after the intervention strategies. The mean difference in weight reduction ranged from

**TABLE III**  
**Anthropometric Measurements (Mean  $\pm$  SD) of Obese Boys Before and After Intervention**

Parameters	Before Intervention	After Intervention	Difference	't' value	F - value
<b>Height (cm)</b>					
Group A	149.9 $\pm$ 0.06	152.3 $\pm$ 0.06	2.4 $\pm$ 0.004	5.00**	25.00**
Group B	150.8 $\pm$ 0.06	153.4 $\pm$ 0.06	2.6 $\pm$ 0.002	9.49**	
Group C	149.7 $\pm$ 0.08	152.1 $\pm$ 0.07	2.4 $\pm$ 0.0009	15.38**	
Control D	148.2 $\pm$ 0.08	150.8 $\pm$ 0.08	2.6 $\pm$ 0.001	12.32**	
<b>Weight (kg)</b>					
Group A	56.1 $\pm$ 6.40	55.1 $\pm$ 7.01	-1.0 $\pm$ 0.37	2.80**	5.38**
Group B	55.3 $\pm$ 4.71	54.1 $\pm$ 4.65	-1.2 $\pm$ 0.11	10.44**	
Group C	53.4 $\pm$ 6.26	52.0 $\pm$ 6.25	-1.4 $\pm$ 0.10	12.91**	
Control D	55.3 $\pm$ 6.47	56.6 $\pm$ 6.42	+1.3 $\pm$ 0.08	15.16**	
<b>Body Mass Index (BMI)</b>					
Group A	23.8 $\pm$ 2.22	22.8 $\pm$ 2.16	-1.0 $\pm$ 0.37	17.37**	7.50**
Group B	24.4 $\pm$ 2.31	23.0 $\pm$ 2.05	-1.4 $\pm$ 0.12	11.37**	
Group C	25.2 $\pm$ 2.61	23.6 $\pm$ 2.60	-1.6 $\pm$ 0.30	5.16**	
Control D	25.2 $\pm$ 3.57	26.3 $\pm$ 3.55	1.1 $\pm$ 0.06	1.23NS	
<b>Body Fat Percentage (%)</b>					
Group A	31.1 $\pm$ 1.90	29.9 $\pm$ 2.04	-1.2 $\pm$ 0.10	16.34**	2.56 <sup>NS</sup>
Group B	30.9 $\pm$ 1.79	29.2 $\pm$ 1.85	-1.7 $\pm$ 0.11	15.46**	
Group C	31.9 $\pm$ 2.63	29.8 $\pm$ 2.80	-2.1 $\pm$ 0.18	11.19**	
Control D	32.0 $\pm$ 2.41	32.5 $\pm$ 2.32	0.5 $\pm$ 0.17	2.81**	

\*\* Significant at 1% level

NS Not significant

1kg to 1.4 kg among all the groups which was found to be significant at one per cent level. A maximum reduction of 1.4 kg was observed in group C which was given a combination of nutrition education, physical activity and snack substitution. The obese boys in control group showed an increase in mean weight by 1.3kg which was statistically significant ( $p < 0.01$ ). The findings were similar to a study

conducted in Australia among 1800 school children where an average of one kg weight reduction was reported after imparting an intervention programme of increased exercise and restricted diet for a period of six months<sup>11</sup>.

The findings of the present study revealed that the mean Body Mass Index

(BMI) of the obese boys given different intervention strategies had a significant reduction ( $p < 0.01$ ). It was observed that the mean BMI value among the obese boys in groups A, B and C were 23.8, 24.4 and 25.2 initially, which reduced to 22.8, 23.0 and 23.6 after intervention and were statistically significant ( $p < 0.01$ ). Group C exhibited a maximum reduction of 1.6 among all groups. With regard to control group D an increase in BMI by 1.1 was observed which was statistically not significant.

Before intervention, the mean body fat percentage of experimental groups A, B and C ranged from 30.9 to 31.9, but after the three types of intervention for four months the body fat percentages reduced to 29.2 to 29.9 which was statistically significant ( $p < 0.01$ ). The reduction was found to be maximum with a mean difference of 2.1 in group C where all three types of intervention strategies were adopted. In the case of control group D the mean body fat percentage increased from 32 to 32.5 which was also statistically significant ( $p < 0.01$ ).

It is revealed from the study that except height which increased in all the groups after four months, the weight, BMI and body fat percentage seemed to decrease after intervention strategies except control group with a maximum reduction in group C which received an integrated approach of nutrition education, physical activity and a low calorie, low fat and high fibre snack substitution.

The anthropometric measurements of obese girls before and after intervention are depicted in Table IV. In the case of

experimental groups A, B and C the height of obese girls was found to range from 138.7 to 143.1 cm before intervention, which increased to 140.3 to 144.5 cm after four months of intervention with a mean difference ranging from 1.4 to 1.6 cm. Control group D also showed an increase of 1.2 cm after four months. The findings revealed that irrespective of intervention the height measurements of obese girls increased, which was found to be statistically significant ( $p < 0.01$ ).

The mean weight of obese girls in Groups A, B and C ranged from 47.9 kg to 50.6 kg before intervention and had reduced to 47.2 to 50.0 kg with a difference of 0.3 to 0.7 after intervention. A statistically significant difference ( $p < 0.01$ ) was found among groups A and B and not in group C. This clearly indicated that nutrition education cum physical activity had a better impact in group B than substitution of snack on the weights of obese girls in group C. In the case of control group D the mean weight of girls increased from 51.6 kg to 53.5 kg after four months which was also statistically significant ( $p < 0.01$ ).

The mean Body Mass Index (BMI) of the obese girls in groups A, B and C was found to be 23.5, 24.9 and 25.6 respectively before intervention and the mean values reduced to 22.8, 24.0 and 24.1 after intervention. The reduction in BMI ranged from 0.7 to 1.5 and was found to be statistically significant in groups A and B and the maximum reduction of 1.5 in the mean BMI was observed in group C. On the contrary an increase in BMI by 1.3 was seen in control group D which was statistically significant ( $p < 0.01$ ).

**TABLE IV**  
**Anthropometric Measurements (Mean  $\pm$  SD) of Obese Girls Before and After Intervention**

Parameters	Before Intervention	After Intervention	Difference	't' value	F - value
<b>Height (cm)</b>					
Group A	143.1 $\pm$ 0.07	144.5 $\pm$ 0.07	1.4 $\pm$ 0.0009	15.27**	13.67**
Group B	138.7 $\pm$ 0.07	140.3 $\pm$ 0.06	1.6 $\pm$ 0.0009	16.55**	
Group C	140.9 $\pm$ 0.07	142.5 $\pm$ 0.07	1.6 $\pm$ 0.0009	17.58**	
Control D	145.5 $\pm$ 0.06	146.7 $\pm$ 0.06	1.2 $\pm$ 0.0008	15.42**	
<b>Weight (kg)</b>					
Group A	48.1 $\pm$ 5.79	47.8 $\pm$ 5.74	-0.3 $\pm$ 0.07	4.51**	14.25**
Group B	47.9 $\pm$ .53	47.2 $\pm$ 4.44	-0.7 $\pm$ 0.08	9.31**	
Group C	50.6 $\pm$ 5.40	50.0 $\pm$ 4.62	-0.6 $\pm$ 0.07	1.59 <sup>NS</sup>	
Control D	51.6 $\pm$ 4.12	53.5 $\pm$ 4.19	1.9 $\pm$ 0.09	9.43**	
<b>Body Mass Index (BMI)</b>					
Group A	23.5 $\pm$ 2.03	22.8 $\pm$ 1.9	-0.7 $\pm$ 0.04	14.38**	6.31**
Group B	24.9 $\pm$ 2.68	24.0 $\pm$ 2.46	-0.9 $\pm$ 0.06	14.52**	
Group C	25.6 $\pm$ 3.76	24.1 $\pm$ 2.01	-1.5 $\pm$ 0.64	2.31*	
Control D	24.6 $\pm$ 2.24	25.9 $\pm$ 2.34	1.3 $\pm$ 0.05	3.22**	
<b>Body Fat Percentage (%)</b>					
Group A	33.6 $\pm$ 1.38	33.4 $\pm$ 1.44	-0.2 $\pm$ 0.03	4.45**	0.81 <sup>NS</sup>
Group B	34.0 $\pm$ 1.25	33.2 $\pm$ 1.19	-0.8 $\pm$ 0.08	9.74**	
Group C	34.3 $\pm$ 1.30	33.7 $\pm$ 1.22	-0.6 $\pm$ 0.07	8.76**	
Control D	33.6 $\pm$ 1.47	34.9 $\pm$ 1.47	1.3 $\pm$ 0.03	8.41**	

\*\* Significant at 1% level

\* Significant at 5% level

NS Not significant.

The mean body fat percentage of obese girls in groups A, B and C was found to be 33.6, 34 and 34.3 respectively which got reduced to 33.4, 33.2 and 33.7 respectively. The reduction in fat percentage was found to range from 0.2 to 0.8 and found to be statistically significant ( $p < 0.01$ ) with a maximum reduction in group B. Control group D exhibited an increase in body fat

percentage by 1.3 which was statistically significant ( $p < 0.01$ ).

The data on mean difference in various anthropometric parameters of obese boys and girls belonging to different intervention groups were subjected to analysis of variance (ANOVA) and the results revealed that the changes observed in the different

parameters after the study period of four months in the different intervention groups was significant ( $p < 0.01$ ). However the changes observed in the control group was not significant.

### Summary and Conclusion

Based on the findings of the present study it can be concluded that school based and family based intervention which includes nutrition education, increased physical activity and substituting of high calorie foods with low calorie, low fat and high fibre foods can be recommended and encouraged which would be effective in the management

of childhood obesity. A concerted effort targeted at improving lifestyles of children and adolescents is needed as childhood obesity trends are disturbing. Effective interventions and preventive strategies should be instituted at the national level with a population based, multi sectoral and multi disciplinary and culturally relevant approach to tackle this societal problem.

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