

Effect of Meal Replacement and Nutrition Education on Obese Adolescent Girls

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Abstract

Obesity has reached epidemic proportions in India in the 21st century, with morbidity obesity affecting five percent of the country's population. Adolescent is a crucial period in life and implies multiple physiological and psychological changes that affect nutritional needs and habits. Meal skipping and eating irregularly are common during adolescence and especially prevalent during middle and late adolescence. High fiber diets provide bulk or more satiating and have been linked to lower body weight. Nutrition education must help teens to become informed decision makers about their diets. Three hundred adolescent girls were involved in screening for obesity. From them forty five adolescents and baseline survey was conducted with them and then they divided into three groups each have 15 members. In this study they researcher has developed high fiber recipes like kozhukattai, roti and porridge using fiber rich ingredients like varagu, horse gram and curry leaves. Four different samples of high fiber recipes were developed using the same ingredients at various proportion and then it was subjected to organoleptic evaluation with 30 semi-trained panel members. Sample III got over all acceptability then other samples in three high fiber recipes. Recipes are subjected to biochemical analysis. Dietary fiber content in kozhukatti, roti and porridge found to be 7g, 8g and 8g respectively. Power point was prepared for nutrition education based on management of obesity and meal replacement given to obese adolescent girls in group I and nutrition education only nutrition education given to group II. After three months of meal replacement and nutrition education, the changes in height, weight, BMI, Waist to hip ratio and body fat percentage were evaluated. From the study results meal replacement was very effective in weight reduction.

Keywords: Obesity, Meal Replacement, Weight Reduction

1. Introduction

The incidence of obesity has risen dramatically in recent years globally and there is an escalating epidemic of overweight and obesity both in developed and developing countries. According to World Health Organization, it is estimated that there are approximately 1.5 billion adolescents (aged 20 years and older) who are overweight and at least 400 million adolescents who are obese worldwide [1]. The World Health Organization has revised the BMI cut-off for Asian Indians and suggested a BMI of 25 kg/m² to define obesity against the 30 kg/m² recommended for Europeans. Adolescent obesity is associated with an

increased risk of adult obesity and subsequent cardiovascular diseases [2]. Girls experience a much larger increase in body fat than boys during adolescence. Adolescent boys typically have significantly less superficial fat, less total body fat and less percentage body fat than adolescent girls [3]. The meal missed most often by adolescent are breakfast and lunch. Breakfast is frequently neglected and is omitted more by teens and young adults than by any other age group in the population. Meal replacements are anything we can consume that is already proportioned and ready to eat –and we can eat the whole thing, often packed with extra protein and fiber for greater satiety. Meal replacements are characterized by liquid formulas, powder

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formulations reconstituted with water or milk, or nutrition bars that are typically fortified with vitamins and minerals and with or without fiber [4]. Consumption of high fiber starchy foods, mainly whole wheat flour and brown rice has gone down considerably and has been replaced by low fiber refined wheat flour and polished rice [5]. Depletion of fiber in our present day diet has resulted in emergence of several disease including diabetes, obesity, cardiovascular disease, gastrointestinal diseases, appendicitis, cancer of colon and constipation [6]. Nutrition education of adolescents should address and identify the limitations and potential problems of fast foods [7]. It should suggest how with proper selection, these foods can be combined and incorporated with other foods into an overall nutritionally adequate food plan. In addition, adolescents need to be taught the skills with which to make wise food choices from available menu items. Nutrition education must help teens to become informed decision makers about their diets [8].

2. Materials and Methods

2.1 Selection of Obese Adolescent Girls

The investigator conducted the study at Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore which is a university exclusively for women. Three hundred adolescent girls in the age group of 18-21 years based on their willingness to participate in the study were selected from six departments of the Faculty of Home science. Necessary permission was obtained from the university authorities to conduct the study. The selected three hundred adolescent girls were screened for obesity. The height of all the three hundred adolescent girls was measured to the nearest 0.01cm. Weight was recorded to the nearest 0.1kg on a digital weighing balance. Body Mass Index (BMI) was calculated and based on the values, 45 obese adolescent girls were selected from three hundred adolescent girls.

2.2 Socio-economic Background and Dietary Pattern of Selected Obese Adolescent Girls

The investigator designed an interview schedule to assess the socio economic background and dietary pattern of the selected obese adolescent girls. A pre-tested questionnaire consisting of 20 multiple choice questions each carrying

one mark was formulated to assess the nutritional knowledge of selected obese adolescents. Questions on the importance of nutrients, skipping of breakfast and role of balanced diet in providing good nutrition was administered to all the obese adolescent girls. The investigator recorded the food intake of the adolescent girls through a three day recall method using a proforma.

2.3 Assessment of Nutritional Status

For measurement of hip circumference, the tape was placed horizontally over the buttocks and the circumference was measured at the point yielding the maximum circumference in centimeters (Plate II). Waist to hip ratio was calculated using the formula:

$$\text{Waist-to-hip ratio} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

Body fat analyzer is a small portable fat analyzing instrument or scale which is non-invasive, safe, cheap and reliable estimation of body composition was used in this study to determine body fat. From the electrical conductivity between both hands of the children, the fat percentage digitally displayed by the instrument was recorded.

3. Formulation and Evaluation of High Fiber Recipes

The investigator selected Varagu, horse gram and curry leaves depending upon their nutritive value. Varagu (*Paspalum scrobiculatum*) known as kodo millet is widely grown around the world for food and fodder. Varagu contains 9g of fiber per 100g. Horse gram (*Dolichos biflorus*) is a legume that is predominantly used in India as part of their daily meals. Fiber content of horse gram is 5.3g per 100g. Curry leaves (*Murraya koenigii*) a green leafy vegetable is rich in fiber (6.4g per 100g). Apart from these ingredients, rice flour was used in the formulated fiber rich recipes for binding. Varagu and horse gram were cleaned, roasted and powdered. Curry leaves were washed thoroughly, shade dried and powdered. The proportion of the ingredients is given in Table 1.

3.1 Organoleptic Evaluation

The standardized flour mixture of 50 gram, 10 gram of chopped onion, green chilli, cumin seeds, salt and 70 ml

of water were added and mixed. Adequate amount of the mixture was taken and made into medium sized balls and pressed with the palm and shaped into kozhukattais and steamed for 15 minutes. Roti was prepared by mixing 50 gram of standardized flour, 10 g of chopped onion, green chilli, cumin seeds, salt and 75 ml of water. It was divided into two equal balls and made into medium sized roti and cooked on non-stick tawa without oil for 15 minutes. 50 g of flour mixture yielded two pieces of roti and each piece weighed 50g after cooking. 50g standardized flour cumin seeds and salt was mixed with 200 ml of water, boiled for 20 minutes and served hot with onion and green chilli. 50 g of standardized flour yielded 200 ml of porridge.

Each recipe namely roti, kozhukattai and porridge were prepared in four different proportions and organoleptic evaluation by 30 semi-trained panel members was

Table 1. Proportion of the ingredients

Ingredients (g)	Sample	Sample	Sample	Sample
	I	II	III	IV
Rice flour	65	50	25	-
Varagu	20	25	50	50
Horse gram	10	20	20	45
Curry leaves powder	5	5	5	5
Total	100	100	100	100

conducted using a score card. All the food samples were evaluated based on characteristics such as appearance, colour, flavor, taste and texture using a 5 point hedonic rating scale. Acceptability score of the recipes are presented in Table 2.

4. Evaluating the Effect of Meal Replacement and Nutrition Education on Weight Reduction among Adolescents

Meal replacement is probably the most valuable and underrated supplement on the market. The selected 45 obese adolescent girls were divided into three groups (2 experimental and 1 control) of 15 each. Experimental group I was given meal replacement and nutrition education and for experimental group II only nutrition education was imparted for a period of three months. Control group did not receive any intervention. For meal replacement, the high fiber recipes were prepared every morning at the Foods Laboratory, Department of Food Science and Nutrition, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore. All the obese adolescents in experimental group I were

Table 2. Acceptability score of the recipes

Recipes	(Maximum Score = 5)					
	Charcteristics					
	Appearance	Colour	Flavour	Taste	Texture	Average score
KOZHUKATTAI						
Sample I	4.6 ± 0.2	4.8 ± 0.1	4.7 ± 0.2	4.8 ± 0.2	4.9 ± 0.1	4.7 ± 0.05
Sample II	4.7 ± 0.1	4.8 ± 0.1	4.8 ± 0.1	4.9 ± 0.1	4.9 ± 0.1	4.8 ± 0.03
Sample III	5	4.8 ± 0.1	4.9	5	4.7 ± 0.1	4.8 ± 0.05
Sample IV	4.2 ± 0.2	4.0 ± 0.1	4.9 ± 0.1	4.4 ± 0.2	4.1 ± 0.2	4.3 ± 0.1
ROTI						
Sample I	4.4 ± 0.2	4.6 ± 0.4	4.7 ± 0.4	4.6 ± 0.1	4.7 ± 0.2	4.6 ± 0.1
Sample II	4.5 ± 0.1	4.6 ± 0.3	4.5 ± 0.2	4.8 ± 0.1	4.7 ± 0.3	4.6 ± 0.1
Sample III	4.7 ± 0.1	4.7 ± 0.4	4.8 ± 0.2	5	4.8 ± 0.1	4.8 ± 0.1
Sample IV	4.3 ± 0.2	4.2 ± 0.2	4.8 ± 0.1	4.5 ± 0.1	4.3 ± 0.3	4.4 ± 0.2
PORRIDGE						
Sample I	4.4 ± 0.1	4.5 ± 0.4	4.2 ± 0.1	4.7 ± 0.1	4.8 ± 0.1	4.5 ± 0.2
Sample II	4.5 ± 0.2	4.8 ± 0.3	4.4 ± 0.1	4.7 ± 0.2	4.8 ± 0.2	4.6 ± 0.2
Sample III	4.8 ± 0.3	4.9 ± 0.1	4.8 ± 0.1	5	4.9 ± 0.1	4.8 ± 0.1
Sample IV	4.3 ± 0.1	4.4 ± 0.4	4.8 ± 0.2	4.7 ± 0.2	4.5 ± 0.1	4.6 ± 0.2

instructed to assemble in the foods laboratory between 9.15-9.45 am every morning. The prepared recipes were served hot. During weekend and holidays, the investigator provided meal replacement flour to adolescent girls for making recipes.

Nutrition education was imparted through power point presentation by lecture method to both experimental groups I and II. The girls were asked to assemble in a classroom and a power point presentation on the management of obesity was given on specific days for a duration of 45 minutes for a period of three months. Discussion was held at the beginning and at the end of the session. A leaflet on obesity management was also distributed by the investigator to the girls belonging to experimental groups I and II.

5. Results and Discussion

The developed recipes were analysed for its nutrient content following the procedures suggested by AOAC method and presented in Table 3.

Nutrient analysis of 100g of the developed recipes revealed that it had a moisture content of 58 percent and 47 percent and 80 percent for kozhukattai, roti and porridge respectively. The developed recipes had a dietary fiber content of 7g, 8g and 8g in kozhukattai, roti and porridge respectively.

The energy content of kozhukattai, roti and porridge was 169 kcal, 213 kcal and 81kcal respectively. Protein also high in developed recipes like 6g in kozhukattai, 7g in roti and 6g in porridge.

The calcium content kozhukattai was 258mg. Roti had a calcium content of 178 mg and the porridge had a calcium content of 241mg. A low fat content of 0.4g, 0.3g and 0.3g was found in kozhukattai, roti and porridge

Table 3. Nutrient content of the developed snacks

Nutrients	Recipes		
	Kozhukattai (100g)	Roti (100g)	Porridge (200ml)
Moisture (%)	58	47	80
Energy (kcal)	169	213	81
Carbohydrate (g)	35	46	13
Protein (g)	6	7	6
Fat (g)	0.4	0.3	0.3
Dietary fiber (g)	7	8	8
Crude fiber (g)	5	6	6
Calcium (mg)	258	178	241
Iron (mg)	2	2	2

respectively. The iron content of the recipes ranged from 1.9 to 2.0mg per serving.

5.1 Cost of the Formulated High Fiber Recipes

The cost of 100g of high fiber recipes was Rs.3.75 whereas for per serving it was Rs.1.88. The developed recipes were less expensive than any other type of processed foods that are currently available in the market.

6. Effect of Meal Replacement and Nutrition Education on Weight Reduction

6.1 Anthropometric Measurements of Obese Adolescent Girls before and after Meal Replacement

The anthropometric measurements of obese adolescent girls before and after meal replacement are presented in Table 4.

The mean height of selected obese adolescent girls in experimental group I slightly changed from an initial value of 1.52cm to 1.53cm after intervention. The mean height of the obese adolescent girls in experimental group II did not change after intervention.

The mean height of the obese adolescent girls in control group also did not change after intervention. Mean difference in height among experimental group I was in the range of 0.1cm and it was found to be significant ($p < 0.01$).

In the present study, the mean weight of selected obese adolescent girls in experimental group I was found to be 62.8kg at the start of the intervention which reduced to 60.8kg after intervention. The mean weight of obese adolescent girls in experimental group II was found to be 67.4kg before intervention which had slightly increased to 67.8kg after intervention. Mean weight of adolescent girls in the control group was found to be 62.8kg in initial stage which had slightly increased to 63.8kg at final stage. In group I, the mean difference in weight reduction was 2 kg which was found to be significant at one per cent level. In experimental group II and control group a mean difference in weight of 0.4kg and 1.0kg was observed which was statistically significant ($p < 0.01$). In this study, when compared to other groups, experimental group I was found to have a maximum reduction.

Table 4. Mean anthropometric measurements of obese adolescent girls before and after meal replacement

Parameters	Mean \pm SD		Mean difference \pm SD	't' value
	Before	After		
Height (cm)				
Group I	152 \pm 0.14	153 \pm 0.1	1.0 \pm 0.1	0.37 ^{NS}
Group II	160 \pm 0.2	160 \pm 0.2	0.1 \pm 0.1	0.001 ^{NS}
Control group	154 \pm 0.1	154 \pm 0.1	0.1 \pm 0.1	0.001 ^{NS}
Weight (kg)				
Group I	62.8 \pm 8.3	60.8 \pm 13.6	-2.00 \pm 1	7.03 ^{**}
Group II	67.4 \pm 7.7	67.8 \pm 8.1	0.4 \pm 2.3	3.7 ^{**}
Control group	62.8 \pm 5.4	63.8 \pm 5.6	1.0 \pm 2.1	3.5 ^{**}
Body Mass Index (BMI)				
Group I	27.6 \pm 0.6	25.8 \pm 1.7	-1.2 \pm 0.5	8.51 ^{**}
Group II	27.3 \pm 5.9	27.5 \pm 5.4	0.2 \pm 1.1	3.4 ^{**}
Control group	26.6 \pm 1.4	26.5 \pm 2.3	0.04 \pm 0.1	5 ^{**}

^{**}Significant at 1% level; NS- Not significant

Group I (N=15): Meal Replacement and Nutrition Education

Group II (N=15): Nutrition Education

Control group (N=15): No intervention

The findings of the study revealed that the mean Body Mass Index (BMI) of the selected obese adolescent girls given different intervention strategies had a significant reduction ($p < 0.01$) in experimental group I. It was observed that the mean BMI value among obese adolescent girls in group I was 27.0 before intervention which reduced to 25.8 after intervention with a mean difference of 1.23 which was statistically significant ($p < 0.01$). The mean Body Mass Index (BMI) of the obese adolescent girls in experimental group II and control group was 27.3 and 26.6 in initial stage which had slightly increased to 27.5 and 26.6 after intervention respectively. The mean difference also slightly increased after intervention at significant level ($p < 0.01$).

6.2 Mean Waist-to-hip Ratio of Selected Obese Adolescent Girls before and after Intervention

Mean waist-to-hip ratio of selected obese adolescent girls before and after intervention is presented in Table 5.

The mean waist-to-hip ratio of selected obese adolescent girls in experimental group I had reduced from an initial value of 0.90 and 0.85 after intervention. The mean difference in waist-to-hip ratio reduction range was 0.05 was found to be significant at five per cent level. In experimental group II mean waist-to-hip ratio of obese girls was 0.96 initially and 0.98 after intervention which was slightly increased. The mean difference in waist-to-

Table 5. Mean waist-to-hip ratio of selected obese adolescent girls before and after intervention

Waist-to-hip ratio	Mean \pm SD		Mean difference	't' value
	Before intervention	After intervention		
Group I	0.90 \pm 0.1	0.85 \pm 0.08	-0.05 \pm 0.1	2.35*
Group II	0.96 \pm 0.1	0.98 \pm 0.1	0.02 \pm 0.1	2.74*
Control group	0.89 \pm 0.1	0.9 \pm 0.1	0.01 \pm 0.2	0.9 ^{NS}

*Significant at 5% level; NS-Not significant

Group I (N=15): Meal Replacement and Nutrition Education

Group II (N=15): Nutrition Education

Control group (N=15): No intervention

hip ratio was found to be increased by 0.02 at significant ($p < 0.05$) level. In control group, the mean waist-to-hip ratio was 0.89 initially and it increased to 0.90 after intervention. Among the control group, mean difference of waist-to-hip ratio was 0.01 which was not found to be significant.

6.3 Mean Body Fat Percentage of Selected Obese Adolescent Girls before and after Intervention

Table 6 presents mean body fat percentage of selected obese adolescent girls before and after intervention.

In the present study, the mean body fat percentage in experimental group I was found to be 36.3 per cent at the beginning of the intervention which reduced to 34.5 per-

Table 6. Mean body fat percentage of selected obese adolescent girls before and after intervention

Body fat percentage	Mean \pm SD		Mean difference	't' value
	Before intervention	After intervention		
Group I	36.3 \pm 2.5	34.5 \pm 2.1	-1.8 \pm 0.9	7.4**
Group II	38.5 \pm 4	38 \pm 4	-0.5 \pm 1.7	3.7**
Control group	36.1 \pm 2.6	35.4 \pm 6	-0.7 \pm 1.6	1.6 ^{NS}

**Significant at 1% level; NS-Not significant

Group I (N=15): Meal Replacement and Nutrition Education

Group II (N=15): Nutrition Education

Control group (N=15): No intervention

cent after intervention. The mean body fat percentage of experimental group II had reduced slightly from 38.5 per cent before intervention to 38 per cent after intervention. In the control group of selected obese adolescent girls the mean body fat percent was found to be 36.1 per cent initially and 35.4 per cent at the final stage of intervention. The mean difference in body fat percentage in experimental group I was 1.8 per cent which was found to be significant at 1 per cent level. The mean difference of experimental group II was found to be 0.5 per cent significant at 1 per cent level. The mean difference of body fat percentage in the control group was found not to be significant.

6.4 Mean Score of Nutritional Knowledge of Selected Obese Adolescent girls before and after Education

Table 7 reveals that mean score of nutritional knowledge of selected obese adolescent girls before and after education.

The finding of the present study revealed that the nutritional knowledge of the selected obese adolescent girls in experimental group I was found to be 10 at the initial stage which increased to 17.6 after intervention. The mean score of nutritional knowledge in experimental group II was 9.4 before intervention which had increased to 15.4 after intervention.

The mean difference in score of nutritional knowledge of obese adolescent girls in experimental group I was found to be 7.6 at significant ($p < 0.01$) level. The mean difference in score of obese girls in experimental group II was 6 at a significant ($p < 0.01$) level.

7. Conclusion

Obesity is a complex condition with serious social and psychological dimensions, that affects virtually all age

Table 7. Mean score of nutritional knowledge of selected obese adolescent girls before and after education

Category	(Mean score=20)			't' value
	Mean \pm SD		Difference	
	Before Education	After Education		
Experimental group I	10 \pm 1.55	17.6 \pm 1.25	7.6 \pm 2.11	13.5**
Experimental group II	9.4 \pm 2.8	15.4 \pm 24.9	6 \pm 1.8	10.39**
Control group	7.6 \pm 2.3	7.5 \pm 1.7	-0.1 \pm 2.0	0.2 ^{NS}

** Significant at 1% level; NS-Not significant

Group I (N=15): Meal Replacement and Nutrition Education

Group II (N=15): Nutrition Education

Control group (N=15): No intervention

and socio-economic groups and threatens to overwhelm both developed and developing countries. This problem is increasing in adolescents and various factors, contribute to it. The mean difference in BMI among obese girls in experimental group I and II and control group was 1.2, 0.2 and 0.04 respectively. Mean BMI value reduced only among experimental group I at significant ($p < 0.01$) level. Mean difference of waist-to-hip-ratio had decreased to 0.05 after intervention in experimental group I. In experimental group II mean difference slightly increased by 0.02 at significant ($p < 0.05$) level. Mean difference in body fat percentage of obese adolescents in group I, group II and control group decreased to 1.8, 0.5 and 0.7 per cent respectively. The 't' value revealed changes at significant ($p < 0.01$) level. The present study revealed that meal replacement with the developed high fiber recipes (Roti, kozhukattai and porridge) and nutrition education was found to be very effective in weight reduction among obese adolescent girls.

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