Nutrition Intervention Program Improves Serum Lipid Profile of Obese Children in Select Schools from Chennai

Gowri Ramesh, Gomathy Shivaji

ABSTRACT

Objective: The objective of this study was to devise an intervention program to improve body mass index (BMI) and serum lipid profile of obese school children in the age group of 10 to 15 years. Materials and Methods: The study comprised of a survey and pretest and posttest experimental design and was conducted over the course of a year. The total of 4289 children from 11 schools were screened for obesity based on age and gender specific cut-off values for BMI. Of the 193 children found to be obese, 49 children enrolled for the intervention program and were assigned to three specific groups using purposive sampling. Group I (Control), Group II (Nutrition Counseling) and Group III (Nutrition counseling and Exercise) comprised of 13, 19, and 17 children-at-risk, respectively. Descriptive analysis was used for assessing details regarding their dietary and physical activity pattern. Paired t-test was used to assess data pertaining to anthropometric measurements such as height, body weight, BMI, waist circumference and serum lipid parameters (total cholesterol [TC], high-density lipoprotein-cholesterol [HDL-C], low-density lipoprotein-cholesterol [LDL-C], very low-density lipoprotein cholesterol, ratio of TC/HDL-C and serum triglycerides). Results: Post intervention, BMI was found to be stable, and there was a significant increase \((P < 0.01)\) in serum HDL-C levels and a significant decrease \((P < 0.01)\) in the ratio of TC/HDL-C in Group III and a significant increase \((P < 0.05)\) in serum HDL-C levels alone in Group II subjects. Conclusion: The intervention study highlights the maintenance of BMI and improvement in serum lipid parameters of children-at-risk who received periodic nutrition counseling.

Key words: Body mass index, children-at-risk, nutrition counseling, obesity, serum lipid profile

INTRODUCTION

The prevalence of childhood obesity is on the rise worldwide, as is the prevalence of obesity-related co-morbidities. This is one of the most alarming public issues facing the younger generation today.

Over the past century, most nutrition research and policies concerning the developing world focused on poverty and under-nutrition. Now, there is growing evidence of a major shift towards overweight and obesity in these societies. In India, childhood obesity is emerging as an important health problem paradoxically co-existing with under-nutrition prevailing in different sections of the population. The country has undergone major socioeconomic transformations in the past two decades, leading to changes in the lifestyles of certain social groups. In a study conducted on school children from 6 schools in Chennai (i.e. from 2 high-income, 2 middle-income and 2 low-income schools), the prevalence of overweight (including obese) adolescents was found to be 22% in high-income schools as compared to 4.5% in low-income schools.[1] Another study conducted among affluent female students in Chennai found the prevalence rate to be 6.2%.[2] In high-income schools of New Delhi, the prevalence of overweight among adolescents was found to be 31%, of which 7.5% were obese. In low- and middle-income schools, prevalence of obesity was found to be 1.4 and 2.5%, respectively.[3,4] In Davangere, Karnataka, the prevalence of obesity among affluent children studying in the 5th–10th grade was found to be 5.74%.[5] These studies indicate that the obesity among children in India is becoming a major public health problem. Although the prevalence of overweight seems to be more than obesity in most parts of India, it is bridging the gap towards obesity.

Department of Home Science, Women’s Christian College, Chennai, Tamil Nadu, India

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Understanding the trends in childhood obesity is important, because obesity in childhood has many adverse effects on health that continues into adulthood. Tracking childhood obesity into adulthood is of equal importance.[6] The presence of increased serum TC, LDL-C, triglyceride (TG), blood pressure, and elevated insulin levels may not be outwardly noticeable during childhood but are indicators of risk for the development of cardiovascular diseases in adulthood.[7,8] Higher levels of serum TG and low high-density lipoprotein-cholesterol (HDL-C) which are the primary lipid abnormalities and related to the amount of visceral fat have been reported in overweight children. Lipid profile screening should be considered as part of the initial evaluation of the obese child, because of the association between dyslipidemia and obesity, the clustering of cardiovascular risk factors in obese individuals and the relatively poor predictive value of family history to predict childhood hyperlipidemia.[9,10]

Children aged 8 years and older, who have a body mass index (BMI) value greater than the 85th percentile, are prone to risk factors associated with obesity.[11] In recent years, BMI has been widely accepted as a valid indirect measure of adipose tissue in both children and adolescents for survey purposes.[12,13] The International Obesity Task Force (IOTF) reference for BMI, which is age- and gender-specific, is currently being used for many population studies.

Studies have reported that Indians as an ethnic group are at high risk for insulin resistance and central obesity, which are predisposing factors for type 2 diabetes mellitus and cardiovascular disease.[14] A rapidly escalating “epidemic” of type 2 diabetes mellitus and cardiovascular disease in India is being recognized. According to Yajnik, although obesity may not be very obvious in Indians when compared with people from the West, the body composition and metabolism of Indians make them especially prone to adiposity-related consequences.[15]

Public health policies in India have so far targeted under-nutrition. Since the epidemic of over-nutrition is gaining momentum, the health policy makers should also consider obesity prevention programs targeting young children. Although intervention studies focusing on lifestyle changes related to dietary and physical activity for children have been conducted in many countries, not many Indian studies on obese children have been reported. With this background in mind, the study focused on management of obesity among children-at-risk in a school-based program. Private schools were selected for this study since prevalence studies on overweight and obesity in earlier Indian studies have reported an increased prevalence in children from a higher socioeconomic group.

MATERIALS AND METHODS

The focus of this study was to determine the prevalence of obesity among school children in the age group of 10–15 years from private schools of Chennai, India; to first identify the children as “obese,” and then devise an intervention program of 1-year duration for the obese children who were inferred to be children-at-risk. This intervention program consisted of nutrition counseling, promoting physical activity, and adapting certain behavior modification techniques. The impact of the intervention program was assessed with respect to diet, and physical activity patterns, certain anthropometric and biochemical parameters.

Ethics committee approval

The Institutional Ethics Committee of the Women’s Christian College, Chennai, approved the protocol of the study. After obtaining the school’s consent for conducting the prevalence study, individual written informed consent was obtained from the parents of children-at-risk who participated in the intervention study. The study protocol was explained in detail to the school authorities, parents, and the selected children-at-risk.

Experimental procedure

Design of the study

The study comprised of a survey and pretest to posttest experimental design with a control group.

Selection of sample

Selection of schools

A set of 11 private schools was selected from five geographic zones - North, East, West, South and Central in the city of Chennai, based on permission granted by the school authorities.

Selection of children

Four thousand two hundred and eighty-nine children of both sexes in the age group of 10–15 years from the schools that had given permission were selected for the prevalence study on obesity. For this purpose, anthropometric measurements such as height, body weight, and waist circumference were assessed for these school children. BMI was calculated for all the children. Based on the IOTF cut-off for age and gender-specific BMI,[16] children were identified as obese.
Selection of sub-sample for the intervention study

Selection of “children-at-risk” for the intervention program was by purposive sampling (Purposive sampling is a sampling technique where subjects are distributed based on their consent to participate in the study). Of the 193 children found to be obese (children-at-risk), 49 children were willing to participate in the study. After explaining the study protocol, using purposive sampling, these 49 children-at-risk were assigned to the following three specific groups based on children’s willingness to attend counseling sessions, participate in games or activities during and after school hours:

Group I: Control Group (13 subjects)

This group comprised of subjects who did not receive periodic nutrition counseling. However, for these subjects, a common nutrition education program on obesity was conducted at the beginning of the study.

Group II: Nutrition counseling (19 subjects)

This group comprised of subjects who were enrolled for an intervention program and were given very specific and periodic nutrition counseling. Subjects were counseled every month on concepts related to healthy eating and benefits of physical activity, and a nutrition education program on obesity was conducted for them. Parents of subjects were invited for counseling sessions and a nutrition education program conducted in the school premises.

Group III: Nutrition counseling and exercise (17 subjects)

This group comprised of subjects who not only received periodic nutrition counseling but also encouraged to take up some physical activity after school hours (this included both free and organized play). Sessions on aerobic exercises taught by a fitness instructor were organized twice a week for these subjects. After 12 sessions, the classes had to be discontinued due to subject’s preoccupation with academic and other school activities. However, some subjects had enrolled in organized after school hours while the others were involved in free play.

Handouts, folders, and bookmarks with nutrition-related advice, were distributed to subjects in all the groups and schools under study.

A schematic representation of the selection of subjects for the study is presented in Figure 1.

Tools used for the study

Questionnaire

A standardized questionnaire was designed to elicit information such as demographic details, family history of diseases, and physical activity pattern from selected children-at-risk.

Interview schedule

An interview schedule was used to elicit information on the dietary pattern of children-at-risk. Nutrient intake for the children-at-risk was estimated using a 24-h dietary recall.

Anthropometric measurements

- Height: Standing height of the subjects was measured using a non-stretchable tape-measure fastened to the wall. The height measurement was recorded to the nearest 0.1 cm
- Body Weight: Body weight of the subjects was measured using a portable weighing scale after adjusting for zero setting. The weight was recorded to the nearest 0.5 kg
- BMI (Quetelet’s index): BMI is obtained by dividing Weight in kilograms by height in meters squared

\[
\text{BMI} = \frac{\text{Weight (in kilograms)}}{\text{Height (in meters squared)}}
\]
Waist circumference (WC): A flexible non-stretchable tape was used to measure the waist circumference of the subjects, one inch above the naval line to the nearest 0.1 cm.

**Biochemical parameters**

The following biochemical parameters were assessed for children-at-risk at pre and post-intervention phase:

- Estimation of fasting plasma glucose by the enzymatic kit method - GOD-PAP method
- Estimation of serum total cholesterol (TC) by the enzymatic kit method - CHOD-PAP method
- Estimation of serum HDL-C by the enzymatic kit method - Precipitation method
- Estimation of serum TGs by the enzymatic kit method - Lipase and Glycerol kinase method.

The enzymatic kit was manufactured by Siemen’s India Ltd.

The following parameters were calculated:

a. Serum LDLc = TC - HDLc - TG / 5(mg / dl)

b. Serum VLDL - C = \( \frac{\text{Triglyceride (mg / dL)}}{5} \)

c. Serum TC : HDL - C ratio = \( \frac{\text{TC}}{\text{HDL-C}} \)

**Collection of blood samples**

From Groups I, II, and III, 6, 10, and 15 subjects, respectively, had blood samples drawn for serum lipid profile tests at pre and post-intervention phase. The biochemical estimations were carried out in Ehrlich Laboratories, a licensed and accredited laboratory based in Chennai city.

**Duration of the study**

The study was conducted between the years 2006 and 2009. Screening for obesity was conducted over a period of 6–8 months. For children-at-risk, intervention was given for a period of 1-year for each child. The education program in schools was conducted over a time frame of 6 months.

**Nutrition education program**

A nutrition education program was conducted at select schools, focusing on the importance of lifestyle changes from childhood, and with the primary goal to prevent or postpone the onset of obesity-related diseases. A program was conducted separately for teachers and all children from the selected schools. Parents were also invited to attend the program. The content of these programs was delivered through presentations using projection slides, puppet shows, posters, interactive games, and skits.

**Statistical analysis**

Descriptive analysis was used for assessing details regarding dietary and physical activity pattern. ANOVA and paired t-test were used to assess data pertaining to anthropometric measurements and biochemical parameters.

**RESULTS**

Impact of the intervention program was assessed among a sub-group of children-at-risk identified from the prevalence study, which consisted of 4289 children from private schools located in the 5 main zones of Chennai city, and these were evaluated as follows:

**Anthropometric measurements of all children**

Based on gender, mean anthropometric measurements of all children were screened, and this is presented in Table 1.

Body weight, BMI, and waist circumference were found to be significantly higher in female subjects.

**Percentage distribution of children based on body mass index**

Children were classified as normal weight, overweight, and obese based on their BMI. This is presented in Table 2.
Prevalence of overweight and obesity was found to be 14.08 and 4.5%, respectively among the population of 4289 children. This prevalence rate was obtained using the age and gender-specific cut-off values for BMI, defined by the IOTF.\[16\]

**Effect of the intervention program in selected children-at-risk**

**General information**

- Most subjects from all the three groups belonged to nuclear families from higher income categories. Based on details regarding occupation, parents of subjects in all the three groups were found to be sedentary workers.
- With regard to family history of diseases, obesity was present to the extent of 51% and 46.9% in fathers and mothers of subjects respectively in all the three groups. Diabetes was largely prevalent among fathers (24.5%) of subjects in all the three groups. Cardiovascular disease was prevalent to a lesser extent (2%) among parents of subjects in the three groups. Hypertension was prevalent to the extent of 28.6% and 18.4% in fathers and mothers of subjects, respectively, in all the three groups.

**Dietary and physical activity pattern**

- Eating out with family at least once a week was observed to be a common practice among subjects in all the three groups.
- A trend toward decreased snacking was observed among most subjects in all the three groups at post-intervention.
- Consumption of fruits and vegetables among subjects in Groups II and III improved by 199% and 200%, respectively, after the intervention.
- At post-intervention, with respect to total energy intake, a decrease was observed among subjects in Groups I and II, while an increase was seen in Group III subjects.
- An increase in protein intake was observed in subjects from Groups I and III, while there was a decrease among subjects in Group II. A decrease in fat intake was observed among all subjects in the three groups. On a comparison with the ICMR recommendations, energy and protein intake was found to be lower than the RDA while intake of fat among subjects in all the groups was found to be higher than the RDA. However, a decrease in the percentage of energy from fat was observed at post-intervention.
- Among subjects in Group III, 100% of the subjects were involved in some form of physical activity indicating a 70.6% increase at post-intervention. Mean hours of play had increased from 3 to 6 h/week. No change in the percentage or mean hours of play was observed among subjects in Group II at postintervention. Among subjects in Group I, the numbers had shown a decrease (by 20%) at post-intervention, but the mean hours of play had increased from 1 to 2 h/week.
- A trend toward decreased television viewing was observed among subjects and their parents in all the three groups at post-intervention.

**Anthropometric measurements**

Anthropometric measurements of subjects are presented in Table 3.

On the comparison of BMI in subjects from the three groups, subjects in Group I had shown a significant increase, while there was a trend toward maintenance of a stable BMI among subjects in Groups II and III.

Periodic assessment of body weight, BMI and waist circumference for subjects from all three groups is reflected in Figures 2-4, respectively.

While there was a sharp rise in the body weight of subjects in Group I, a slight decline between the 16th and 32nd week.
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but there was a trend towards maintenance among subjects in Groups II and III. Waist circumference showed a steep decline and rise among subjects in Group I. Subjects in Group II showed an increasing and decreasing trend, while in subjects from Group III, a decrease was indicated with a rise towards the period of final assessment. However, in subjects from all three groups, a non-significant decrease from the initial values was observed at post-intervention.

Biochemical assessment

Serum lipid profile

Serum lipid levels of subjects were compared with the NCEP and ADA guidelines. Among subjects in Group I, all serum lipid parameters were found to be higher, while serum HDL-C levels lower, when compared with subjects in Groups II and III at pre and post-intervention. The ratio of TC:HDL-C indicated that these subjects were at a higher risk for cardiovascular diseases. Among subjects in Groups II, serum HDL-C levels had shown a significant improvement ($P < 0.05$). The ratio of TC:HDL-C was well within the desirable range at post-intervention. For subjects in Group III, serum HDL-C levels had shown a significant improvement ($P < 0.01$) and the ratio had a shown a significant decrease ($P < 0.01$) at post-intervention. The other serum lipid parameters were also found to be within the normal range after intervention. Serum lipid levels of subjects are presented in Table 4.

DISCUSSION

Anthropometric measurements recorded among 4289 children showed higher measurements in females. This could be due to higher levels of inactivity observed among females when compared with males. Physical inactivity has been inversely related to anthropometric measurements as reported in some studies.[17,18] Pubertal changes, which happen in this age group, could have also contributed to the higher body weight and BMI noticed among female children.

Prevalence in childhood obesity rates is found to be closer to other studies conducted in different parts of India such as Hyderabad, Davangere, and Delhi.[4,5,19] The IOTF report (2004) stated that in some developing countries, childhood obesity is most dominant in wealthier social groups and is rising among the urban poor, possibly due to their exposure to Westernized diets coupled with a history of under-nutrition. Frequent consumption of high-calorie snacks and fast foods is one of the rising causes of obesity among children.[20] Higher income among families also enables the purchase of mechanized devices. This further compounds the sedentary lifestyles of people. All these environmental factors could be a trigger for weight gain in children as well as in adults. This trend is currently noticeable in the metro cities of India, where the joint family system is changing to the nuclear family system. As a result,
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### Table 4: Mean serum lipid levels of subjects enrolled in the intervention program at pre and post-intervention phase

<table>
<thead>
<tr>
<th>Serum lipid parameter (mg/dl)</th>
<th>Mean±SD</th>
<th>Test of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group I (n=6)</td>
<td>Group II (n=10)</td>
</tr>
<tr>
<td>TC</td>
<td>Pre*</td>
<td>Post*</td>
</tr>
<tr>
<td>TC</td>
<td>161.8±23.4</td>
<td>163.5±11.0</td>
</tr>
<tr>
<td>HDL-C</td>
<td>33.2±5.2</td>
<td>33.2±4.8</td>
</tr>
<tr>
<td>LDL-C</td>
<td>101.3±24.8</td>
<td>105.4±14.8</td>
</tr>
<tr>
<td>VLDL-C</td>
<td>27.3±17.6</td>
<td>24.9±11.0</td>
</tr>
<tr>
<td>TG</td>
<td>136.7±86.9</td>
<td>124.8±55.0</td>
</tr>
<tr>
<td>TC:HDL-C ratio</td>
<td>5.0±1.1</td>
<td>5.1±0.9</td>
</tr>
</tbody>
</table>

\*Mean serum lipid levels of subjects enrolled in the intervention program at pre and post-intervention phase


In many households, traditional foods are being replaced with processed convenience foods or frequent eat outs.

In the present study, periodic counseling helped subjects and their families realize the health hazards associated with frequent eat-outs, and choosing wisely the healthier options while dining out. With respect to subjects’ diet pattern, a trend toward decreased consumption of junk foods and awareness about its health hazards was observed among the majority (all Groups) of them. Other positive indicators were an increased consumption of fruits and vegetables, and decreased intake of fat among subjects who received periodic counseling. An improvement in the physical activity pattern was also observed at post-intervention.

Studies have reported that parental obesity more than doubles the risk of adult obesity among both obese and non-obese children. Diabetes and impaired glucose tolerance are noted particularly in obese children with a family history of diabetes. Educating children on healthy lifestyles from a young age and addressing childhood obesity can prevent or postpone the onset of obesity-related disorders.

Some intervention programs conducted globally have also shown varying results on BMI. In children, the Active Program Promoting Lifestyle Education and the Child and Adolescent Trial for Cardiovascular Health study did not show any significant changes in BMI even after a 1-year intervention. On the contrary, a 12-week study (Girls Health Enrichment Multi Site Studies) involving African-American girls in an after-school and summer camp program, showed a decrease in BMI and waist circumference at the end of the study period. In the present study, subjects had exhibited higher values of height and body weight as compared to the expected increase in these parameters that occurs during childhood and adolescence. This had resulted in the higher BMI. However, the trend towards a stable BMI was observed among subjects in Groups II and III, which could be attributed to the effects of periodic nutrition counseling.

Studies have indicated that for interventions to be effective, it should take into account nutrition education, diet, and exercise counseling with behavioral strategies. With respect to the mean nutrient intake, even though the energy intake of all subjects’ was in the normal range, percentage of energy from fat was higher than 30% in subjects from the three groups. Since increased fat intake is an important determinant in the development of obesity, this could have also contributed to the increase in their body weight or BMI. Alternately, at post-intervention, the increase in BMI among subjects in Group III could have resulted from an increase in fat-free mass, because of increased physical activity.

According to the National Lipid Association (2008), early intervention for those who are overweight or obese in childhood is of key importance and a lifelong approach to cardiovascular disease prevention is instrumental in reducing mortality and morbidity from dyslipidemia. Thus, an improvement in the serum lipid parameters of the subjects has reinforced the role of periodic nutrition counseling in bringing about a desirable serum lipid profile among children, as clearly observed in this study. Serum HDL-C is known to have a protective role against cardiovascular diseases, and it is, therefore, essential to maintain high HDL-C levels from childhood. Improvement of this single parameter may show many health benefits.
To summarize, periodic counseling had shown a clear positive trend in improving and managing obesity among children in a school setting. An improvement in dietary and physical activity pattern was observed among subjects who received periodic nutrition counseling. Changes in anthropometric parameters were observed which indicated a positive overall improvement. Although body weight showed an increase in most subjects, BMI more or less remained stable. Furthermore, WC showed a marginal decrease in all the subjects. Periodic counseling had indicated a significant increase in serum HDL-C levels of subjects in Groups II and III. The TC:HDL-C ratio, which is indicative of risk factors for cardiovascular diseases showed a significant reduction among subjects in Groups III and a non-significant reduction among subjects in Group II. The other serum lipid parameters also indicated a decreasing trend at the end of the intervention. All of the above parameters are positive indicators toward combating metabolic features (dyslipidemia such as elevated TGs and decreased HDL-C known to be associated with obesity.

CONCLUSION

The study shows a significant increase in serum HDL-C levels among subjects who received periodic counseling. However, there is a need for an intervention study in a larger sample size and a longer duration. It stands to reason that reinforcement by counseling and continued nutritional education would benefit the children from an early age. The current epidemic of adiposity demands that such programs get incorporated in school health education. That would help inculcating healthy eating habits and the central importance of physical activity in the minds of growing children.

REFERENCES


Address correspondence to:
Dr. Gowri Ramesh,
Old No. 77, New No. 44, Luz Avenue, 5th Street, Mylapore, Chennai ‑ 600 004, Tamil Nadu, India.
E‑mail: gowraram@gmail.com

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