Original Article

Effectiveness of Lifestyle Intervention in Treatment of Pediatric Obesity

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Background: Lifestyle intervention is the cornerstone of the treatment in pediatric obesity. Various interventions have resulted in different degrees of reduction in body weight and cardiovascular outcomes.

Objective: To demonstrate the real-life effectiveness of obesity treatment in weight reduction among lifestyle intervention and usual care in our center and improvement of the cardiovascular risk factors.

Materials and Methods: A retrospective data of 170 first diagnosed, obese children and adolescents, aged 2 to 18 years were collected. All had been followed up for at least 12 months. Sixty-three patients received intensive nutrition education in the nutrition clinic and 107 received usual care in the general pediatric clinic and other subspecialty clinics of the Out-Patient Department of Thammasat Hospital.

Results: The overall BMI significantly reduced with the mean of 0.41 SDS ($p < 0.001$). The mean BMI-SDS in the patients from the nutrition clinic had a significantly greater reduction as compared to the patients from the other clinics [–0.8 (95% CI –1.2 to –0.4) and –0.3 (95% CI –0.5 to 0), respectively; $p=0.009$]. The patients in the nutrition education program had 1.5 greater rate of the successful treatment than the patients that received usual care [RR 1.5 (95% CI 1.0 to 2.1); $p=0.05$]. There were significant improvements of total cholesterol and HDL-cholesterol at the end of the 1-year period.

Conclusion: Intensive nutrition education program promoted a greater rate of successful weight reduction as compared to usual care. Patients who successfully reduced their weight had a greater improvement in some cardio-metabolic parameters.

Keywords: Cardiovascular risk, Childhood obesity, Lifestyle modification, Pediatric obesity, Weight loss

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During the past decade, the prevalence of overweight and obesity among Thai children and adolescents has increased dramatically. According to the reports from the National Health Examination Survey conducted in 1996 to 1997 and 2008 to 2009, the prevalence of overweight and obesity among children and adolescents has increased from 5.8% to 8.5% in children aged 2 to 5 years and 5.8% to 9.7% in children aged 6 to 14 years, respectively[1]. Using the body mass index (BMI) for age standard proposed by the International Obesity Task Force (IOTF), the prevalence of overweight and obesity among Thai children and adolescents aged 3 to 18 years was 15.7%[2].

Overweight children have greater risks for various cardiovascular risk factors such as dyslipidemia, hypertension, insulin resistance, and develop obesity through adolescence and adulthood[3,4]. Lifestyle modification and family intervention seem to be effective in the treatment of childhood obesity in the health care setting. The effectiveness of lifestyle intervention has been reported to have a greater impact on weight loss as compared to no treatment, usual care, or written education materials[5]. Various intensity and components of interventions targeting dietary, physical activity, and behavioral modification have resulted in different degrees of reduction in body weight and cardiovascular outcomes[6]. There was a dose-response relationship between the estimated hours of contact during the treatment and the BMI reduction, with greater contact hours being associated

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with larger effects of the BMI reduction[7].

The clinical importance of weight reduction in obese children is controversial. Lifestyle interventions lead to significant improvements in cardiovascular risk factors including low-density lipoprotein cholesterol, triglyceride, fasting insulin, and blood pressure up to one year from baseline[5]. Recently, a meta-analysis reported that lifestyle intervention in treating childhood obesity had no benefit for lipid profiles[7]. These improved metabolic parameters seemed to be associated with the amount of weight reduction. A BMI standard deviation score (BMI-SDS) reduction of at least 0.5 was reported to have a clinical relevance with a reduction in various cardiovascular risk factors in children aged four to fifteen years[8-10]. One study even demonstrated significant improvement in hypertension, hypertriglyceridemia, and low HDL-C with a reduction in BMI-SDS of 0.25 or greater[11].

The aim of the present study was to demonstrate the real-life effectiveness of obesity treatment in weight reduction among lifestyle intervention and usual care in the authors' center. Changes in the cardiovascular risk factors during the weight reduction treatment were also measured.

Materials and Methods

A retrospective cohort data of obese children and adolescents were collected. The eligible criteria were the newly diagnosed obese children and adolescents aged 2 to 18 years of age that attended the Out-Patient Department of Thammasat Hospital and had been followed up for at least 12 months between January 2012 and December 2015. The authors excluded all patients who had secondary causes of obesity such as endocrinologic or genetic abnormalities and usage of any obesogenic agents. Study size was estimated by using the power analysis for a two-sample means test. The authors estimated 55 and 110 patients from the nutrition and other clinics, respectively.

The patients' data were collected from the nutrition clinic (study group), general pediatric, and other subspecialty clinics (control group). The usual advice for obese patients who attended the general pediatric clinic and other clinics were healthy eating and caloric restrictions including snacks and beverages. The obese patients in the nutrition clinic were advised on lifestyle modifications for diet, meal planning (with a hypocaloric diet consisting of recommended protein for their age and gender, which is 25% to 30% fat with saturated fatty acids of less than 7%, polyunsaturated of up to 10%, and monounsaturated of up to 15%, and carbohydrates for the remainder of calories), food substitution and choices, increased fiber intake, eating less red meat and more fish, and reducing sweetened beverages, by a dietitian and a pediatric nutritionist. Recommended exercise of at least 60 minutes of moderate- to vigorous-intensity physical activity was based on walking, cycling, and swimming. A diary for food consumption and physical activity records were given to the patients who attended the nutrition clinic. The follow-up period in all clinics was every two to six months.

Patients' demographic data, body weight, height, and systolic and diastolic blood pressure at the beginning and at the one-year follow-up period of the treatment were obtained from the medical records. Developmental and behavioral problems such as learning disabilities, attention deficit, and autistic spectrum disorders were also recorded. Collected laboratory data consisted of the fasting lipid profile, which included total cholesterol, high-density lipoprotein cholesterol [HDL-C], low-density lipoprotein cholesterol [LDL-C], triglycerides [TG]), fasting plasma glucose (FPG), and alanine aminotransferase (ALT). The body mass index was defined as the weight in kilograms divided by the square of the height in meters (kg/m^2). Obesity was defined as weight-for-height greater than 3 standard deviations above the median of WHO Child Growth Standard for children under five years of age and BMI-for-age greater than 2 standard deviations above the median of WHO Growth Reference for children over five years of age and adolescents, according to the WHO criteria[12]. The BMI-SDS was used to determine the body weight outcome since it was the only parameter that could be compared to different degree of excess weight across all ages. The success of weight reduction therapy was defined as a reduction in BMI-SDS at least 0.5, which corresponded to the reduction in cardiovascular risk factors in children aged between 4 and 15 years[13]. The Ethics Committee of Thammasat University approved the protocol.

Statistical analysis

Demographic and biochemical data were reported as means ± standard deviation (SD) or 95% confidence interval (CI). Paired t-test and chi-square test were used to test for the differences in the variables between baseline and at 12-month follow-up values. Mean changes of BMI-SDS and metabolic parameters were adjusted for age, gender, and the BMI-SDS or its value at baseline using linear regression analysis. Multivariable regression analysis was used to investigate the association between the treatment

Table 1. Demographic data of obese children and adolescents at baseline

Characteristics	Total (n=170) n (%)	Nutrition clinic (n=63) n (%)	Other clinics (n =107) n (%)	p-value
Age (years), Mean±SD	9.2±3.7	9.8±3.9	8.8±3.6	0.096
2 to 5.9	37 (21.8)	12 (32.4)	25 (67.6)	0.642
6 to 11.9	98 (57.7)	36 (36.7)	62 (63.3)	
12 to 18	35 (20.6)	15 (42.9)	20 (57.1)	
Sex: male	121 (71.2)	46 (73.0)	75 (70.1)	0.729
Weight-for-height-SDS, Mean±SD	5.2±3.9	6.2±5.5	4.5±2.5	0.006*
BMI-SDS, Mean±SD	4.2±2.1	4.7±2.4	3.8±1.7	0.004*
2 to 2.99	63 (37.1)	19 (30.2)	44 (69.8)	0.046*
3 to 3.99	44 (25.9)	13 (29.5)	31 (70.5)	
>4	63 (37.1)	31 (49.2)	32 (50.8)	
Developmental/behavioral disorder	49 (28.8)	16 (25.4)	33 (30.8)	0.487

BMI-SDS=body mass index-standard deviation score; SD=standard deviation

* p-value is statistically significant

Table 2. BMI and metabolic parameters at baseline and 1-year-follow up period

Variables	Overall, Mean±SD			Nutrition clinic, Mean±SD			Other clinics, Mean±SD		
	Baseline	1 year	p-value	Baseline	1 year	p-value	Baseline	1 year	p-value
BMI-SDS	4.2±2.1	3.7±2.2	<0.001*	4.7±2.5	4.0±2.3	<0.001*	3.8±1.8	3.6±2.2	0.091
Total cholesterol (mg/dL)	178.7±27.2	172.2±30.8	0.024*	175.2±28.5	172.4±30.8	0.187	184.5±24.6	171.8±31.7	0.038*
LDL-cholesterol (mg/dL)	115.4±23.8	110.2±29.3	0.121	112.7±22.9	116.0±31.2	0.174	120.5±26.9	102.6±25.1	0.009*
HDL-cholesterol (mg/dL)	44.1±8.7	48.0±11.2	0.002*	46.9±9.0	51.5±11.5	0.007*	39.8±6.1	42.2±8.1	0.079
Triglyceride (mg/dL)	120.4±67.9	114.3±67.5	0.190	105.2±55.7	100.6±50.7	0.272	144.5±79.4	136.0±84.9	0.072
FPG (mg/dL)	88.1±7.2	87.8±7.2	0.417	86.4±6.6	87.8±6.5	0.181	91.9±7.2	87.8±8.8	0.038*
ALT (IU/L)	57.3±44.9	57.6±60.1	0.513	51.4±40.5	55.9±44.8	0.301	66.9±51.6	60.3±81.2	0.729
SBP (mmHg)	116.0±14.1	115.6±11.9	0.374	116.3±14.2	115.9±12.7	0.423	115.8±14.0	115.5±11.5	0.399
DBP (mmHg)	70.6±12.2	68.7±12.0	0.056	69.6±12.9	66.6±13.9	0.073	71.2±11.7	70.0±10.5	0.205

BMI-SDS=body mass index-standard deviation score; LDL=low-density lipoprotein; HDL=high-density lipoprotein; FPG=fasting plasma glucose; ALT=serum alanine aminotransferase; SBP=systolic blood pressure; DBP=diastolic blood pressure; SD=standard deviation

* p-value is statistically significant

success categories and factors that might influence them. A p-value less than 0.05 of two-tailed test was considered to be statistically significant. Statistical analyses were conducted using Stata version 14.0 (StataCorp LP, College Station, TX).

Results

One hundred seventy patients were matched with the present study eligible criteria. The mean age of the population was 9.2 years. The mean BMI-SDS at baseline was 4.2±2.1. The mean weight for height-SDS and BMI-SDS at baseline were higher in the patients from the nutrition clinic compared to those in the other clinics (Table 1). The overall BMI demonstrated a statistically significant reduction with a mean of 0.41 SDS (95% CI 0.17 to 0.64; p<0.001). Among the metabolic parameters, the authors found a significant decrement in total cholesterol and significant increment in HDL-C at the end of one year. The patients that attended the nutrition clinic had significantly decreased in BMI-SDS and increased in HDL-C, while patients that attended other clinics had significantly decreased in total cholesterol, LDL-C, and FPG (Table 2). After the subgroup analysis,

Table 3. Changes in BMI and metabolic parameters after 1-year of treatment

Variable	Nutrition clinic (n=63) Mean (95% CI)	Other clinics (n=107) Mean (95% CI)	p-value	Adjusted p-value
Changes of BMI-SDS	–0.8 (–1.2 to –0.4)	–0.3 (–0.5 to –0.04)	0.019*	0.047*
Changes of metabolic parameters				
Total cholesterol (mg/dL)	–2.8 (–9.0 to 3.5)	–12.7 (–26.8 to 1.5)	0.136	0.111
LDL-cholesterol (mg/dL)	3.3 (–3.8 to 10.5)	–17.9 (–32.2 to –3.7)	0.003*	0.016*
HDL-cholesterol (mg/dL)	4.6 (1.0 to 8.2)	2.5 (–1.1 to 6.0)	0.414	0.127
Triglyceride (mg/dL)	–4.5 (–19.7 to 4.6)	–8.5 (–36.8 to 19.8)	0.782	0.721
FPG (mg/dL)	1.5 (–1.8 to 4.8)	–4.1 (–8.7 to 0.5)	0.049*	0.235
ALT (IU/L)	–4.5 (–13.3 to 4.3)	6.6 (–33.9 to 47.1)	0.479	0.916
SBP (mmHg)	–0.3 (–3.7 to 3.1)	–0.4 (–3.7 to 2.9)	0.971	0.875
DBP (mmHg)	–3 (–7.1 to 1.1)	–1.2 (–4.1 to 1.7)	0.460	0.103

BMI-SDS=body mass index-standard deviation score; LDL=low-density lipoprotein; HDL=high-density lipoprotein; FPG=fasting plasma glucose; ALT=serum alanine aminotransferase; SBP=systolic blood pressure; DBP=diastolic blood pressure

* p-value is statistically significant

Adjusted p-value was calculated by linear regression analysis, adjusted for its baseline value, age, and sex

significant decreased in total cholesterol and LDL-C and a significant increase in HDL-C were found in the boys and only HDL-C was significantly increased in the girls (data are not shown).

After adjusting for baseline BMI-SDS, age, and gender, the mean BMI-SDS in the patients from the nutrition clinic was significantly greater reduced comparing to the patients in the other clinics [–0.8 (95% CI –1.2 to –0.4) and –0.3 (95% CI –0.5 to 0), respectively, p=0.047]. After adjusting for age, gender, and its baseline value, changes in all cardiovascular risk factors among patients in nutrition and other clinics were not significantly different except for the greater reduction of LDL-C in the patients that attended other clinics (Table 3).

Altogether, 36.5 percent of the patients were successful in reducing their BMI more than 0.5 SDS at the one-year period. The patients who had successful weight reduction had significantly higher weight-for-height-SDS and BMI-SDS at baseline compared to the patients in the treatment failure group (p<0.001). The treatment success group had more patients from the nutrition clinic. Among all of the metabolic parameters, the treatment success group had a greater reduction in total cholesterol and LDL-C after one year of treatment, compared to the treatment failure group, adjusted for BMI-SDS at baseline, age, and gender (Table 4).

Using multivariable risk ratio regression, patients from the nutrition clinic had 1.5 greater rate of successful treatment than the patients that attended the other clinics [RR 1.5 (95% CI 1.0 to 2.1); p =0.05]. The patients who had a baseline BMI-SDS of more than 4, had a significantly more successful rate of weight reduction [RR 2.5 (95% CI 1.5 to 4.2); p=0.001]. None of the other factors increased the rate of successful weight reduction (Table 5).

Discussion

The present study demonstrated the population-based, short-term outcomes of the obesity treatment in children and adolescents. Two previous meta-analyses reported the overall BMI-SDS reduction of 0.10 (95% CI 0.02 to 0.18) and 0.25 (95% CI 0.14 to 0.36), with high heterogeneity in the intensity and component of the interventions[5,6]. The intervention in the present study was considered to be a very low intensity intervention, according to the US Preventive Services Task Force, which provided less than 10 hours over the course of the treatment period[14]. A meta-analysis reported a BMI-SDS reduction within the very low intensity group of 0.17 (95% CI 0.08 to 0.25)[7]. The obese patients in the present study had a greater BMI-SDS reduction as compared to the previous reports [0.41 (95% CI 0.17 to 0.64)].

The attendance in the nutrition clinic represented the intervention group for the intensive nutritional education program, while attendance in the general pediatric clinics or other clinics were considered to have usual care or minimal intervention and served

Table 4. Characteristics and changes in metabolic parameters after 1-year of treatment among treatment success and treatment failure group

Variable	Treatment success (n=62, 36.5%) Mean (95% CI)	Treatment failure (n=108, 63.5%) Mean (95% CI)	p-value	Adjusted p-value
Age (years), Mean±SD	8.1±4.0	9.8±3.3	0.004*	-
Sex: male, n (%)	43 (69.3)	78 (72.2)	0.727	-
Attendance at nutrition clinic, n (%)	30 (48.4)	32 (29.6)	0.007*	-
Changes of weight-for-height-SDS	−1.5 (−1.8 to −1.2)	0.7 (0.4 to 1.0)	<0.001*	<0.001*
Changes of BMI-SDS	−1.5 (−1.9 to −1.1)	0.2 (−0.8 to 0.3)	<0.001*	<0.001*
Changes of metabolic parameters				
Total cholesterol (mg/dL)	−15.8 (−28.9 to −2.7)	−3.2 (−11.9 to 5.4)	0.058	0.008*
LDL-cholesterol (mg/dL)	−12.2 (−24.6 to 0.2)	2.1 (−7.3 to 11.5)	0.106	0.002*
HDL-cholesterol (mg/dL)	2.9 (1.9 to 7.8)	4.7 (1.8 to 7.5)	0.493	0.873
Triglyceride (mg/dL)	−25.7 (−45.9 to −5.4)	−5.5 (−35.6 to 24.5)	0.069	0.269
FPG (mg/dL)	−6.5 (−15.1 to 2.2)	−7.7 (−26.8 to 11.4)	0.345	0.695
ALT (IU/L)	−5.6 (−30.9 to 19.7)	4.8 (−15.5 to 25.2)	0.495	0.129
SBP (mmHg)	−0.4 (−5.1 to 4.3)	0.1 (−2.9 to 3.1)	0.871	0.610
DBP (mmHg)	−2.5(−6.6 to 1.6)	−2.5 (−5.5 to 0.6)	0.994	0.401

BMI-SDS=body mass index-standard deviation score; LDL=low-density lipoprotein; HDL=high-density lipoprotein; FPG=fasting plasma glucose; ALT=serum alanine aminotransferase; SBP=systolic blood pressure; DBP=diastolic blood pressure; SD=standard deviation

* p-value is statistically significant

Adjusted p-value was calculated by linear regression analysis, adjusted for BMI-SDS at baseline, age, and sex

Table 5. Factors influencing successful weight reduction

Variables	Success rate ratio	95% confidence interval	p-value
Attendance at nutrition clinic	1.5	1.0 to 2.1	0.050*
Sex: female	1.4	0.9 to 2.1	0.129
Preschool age	1 (reference)		
School age	0.8	0.5 to 1.2	0.212
Adolescents	1	0.5 to 1.8	0.935
BMI-SDS at baseline			
2 to 2.99	1 (reference)		
3 to 3.99	0.9	0.5 to 1.9	0.864
>4	2.5	1.5 to 4.2	0.001*
Behavioral problems	1.1	0.7 to 1.7	0.624

BMI-SDS=body mass index-standard deviation score

* p-value is statistically significant

as a control group. The pooled BMI-SDS change after the lifestyle intervention from four studies was reported to be 0.09 SDS (95% CI 0.02 to 0.15), greater than the usual care or minimal intervention[5,15-18]. The present study demonstrated a greater effect size. The BMI-SDS change was statistically significant only in the intervention group. The patients in the intervention group had significantly higher BMI-SDS at baseline than in the control group. However, after adjusting for age, gender, and BMI-SDS at baseline,

the intervention group still demonstrated a greater reduction in BMI-SDS [–0.8 (95% CI –1.2 to –0.4) and –0.3 (95% CI –0.5 to 0), respectively; p=0.047] and greater rate of successful treatment than the patients in the other clinics.

The present study demonstrated a significant improvement in total cholesterol and HDL-C in overall patients after a one-year period. The clinical importance of weight reduction in childhood is still controversial. Lifestyle intervention was associated with significant improvements in LDL-C, triglycerides, fasting insulin, and blood pressure up to one year from baseline[5]. Some studies considered a BMI-SDS reduction of greater than 0.25 or 0.5 to be associated with greater improvement in hypertension, hypertriglyceridemia, and low HDL-C[8,10,11]. Controversially, a meta-analysis reported that even high intensity intervention, with 52 or more contact hours, showed improvement in only systolic and diastolic blood pressure, and neither lipid profiles nor fasting plasma glucose was significantly improved. Cardio-metabolic outcomes were not associated with any improvement in less intensive interventions[7]. The effect size of weight reduction in different studies may influence the scale of improvement in cardio-metabolic outcomes. The present study demonstrated a great reduction in BMI-SDS, with a mean of 0.41 SDS, thereby, improvement in some lipid profiles was detected in overall patients.

Surprisingly, comparing the cardio-metabolic parameters among the intervention and control groups, the authors found an overall greater reduction of LDL-C in the control group. This was somewhat misleading because the few outliers who had a considerable LDL-C reduction were all in the control group. This could not be explained by the effect of lipid-lowering medications, since the four patients received the medications included three that were in the intervention and one that was in the control group. Lowering LDL for these few patients in the control group could be explained by having successful weight reduction. In the present study, the treatment success group with a BMI-SDS reduction of 0.5 or greater in a one-year period had a significantly greater reduction of total cholesterol and LDL-C as compared to the treatment failure group. However, other cardio-metabolic parameters were not different in both groups. This may due to lack of power or the small effect size of the very low intensity intervention.

The authors demonstrated that lifestyle modification remains an effective intervention in treating childhood obesity as compare to usual care. Patients from the nutrition clinic had 1.5 greater rate to have successful weight reduction as compared to the control group, using multivariable risk ratio regression to eliminate the influence of gender, age, BMI-SDS at baseline, and behavioral problems.

Conclusion

The present study demonstrated the effectiveness of the treatment, including dietary, physical activity, and behavioral modification, in terms of weight reduction and improvement in some cardio-metabolic parameters in real-life setting. Our intensive nutrition education program promoted a greater rate of successful weight reduction. Patients with successful weight reduction had a greater improvement in some cardio-metabolic parameters. These effective interventions are recommended in the treatment of obese children and adolescents.

What is already known on this topic?

Lifestyle modification is effective in the treatment of childhood obesity in various health care settings. The effectiveness of lifestyle intervention has been reported to have the impact on weight loss as well as the improvement of various cardio-metabolic parameters.

What this study adds?

In this population-based setting, different intensity of advices have resulted in different degrees of weight reduction. Formal and intensive nutritional advice in nutrition clinic has a greater impact on weight loss as compared to usual care, independent of degree of obesity at diagnosis, age, and gender.

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Conflicts of interest

The authors declare no conflict of interest.

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