

Childhood Obesity: An Overview

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Extent of the problem

Childhood obesity has already emerged as a global epidemic. An estimated 22 million children under five are estimated to be overweight worldwide.¹ From the two national surveys of 7-13 year-old Canadian children between 1981 and 1996, the prevalence increased from 11 to 33% in boys and from 13 to 27% in girls for overweight and from 2 to 10% in boys and from 2 to 9% in girls for obesity over the 15 years.²

The problem increasingly extends into the developing world in which under-nutrition is still prevalent. For example, the 2001 national survey of Thai children and adolescents aged 1-18 year using the Thai Growth Reference 1995 found 5.4% underweight and 6.2% stunted children. Meanwhile the number of obese preschool children increased from 5.8% in the 1996 National Health Examination Survey to 8% in 2001.³ A recent nation-wide survey of 47,389 grade 6 students from 268 primary schools in the urban settings in 2005 found 16.7% overweight and obese students.⁴ Obesity may mask underlying deficiencies in vitamins and minerals. Thus, increasing childhood obesity with its adverse metabolic consequences in addition to the existing under nutrition is a threat to health of the nation.

Burdens of the problem: consequences and costs

Childhood obesity poses significant hazards and long-term health and socio-economic consequences to the afflicted children. Numerous health risks have been documented including increased stress on weight-bearing joints resulting in slipped femoral epiphyses and Blount's disease or tibia valgus, high blood pressure and abnormal blood lipids, insulin resistance and type 2 diabetes mellitus, asthma and obstructive sleep apnea, gall stone and steatohepatitis.⁵

Co-morbidities of obesity are increasingly evident in the young age. Type 2 DM in Thai children and adolescents has increased from 5% during 1986-1995 to 17.9% during 1996-1999 coinciding with the period of increasing childhood obesity.⁶ The mean age of this patient group was 11.6 years and mean BMI was 27.8 kg/m².

Overweight can also have a damaging impact on psychosocial development and school performance. From a longitudinal study of grades 7-9 students in Thailand, after controlling for gender, age, school and grade, children who became overweight over the two years had a mean GPA of 0.48 point lower than those who remained non-overweight (95% confidence interval: 0.12, 0.84).⁷ In another

study from the USA, after adjustment for grade level, race, and parental socioeconomic status, obese female adolescents, when compared with their average weight peers, were more likely to report hopelessness and a suicide attempt in the last year.⁸

Child-onset overweight increases adult morbidity and mortality risk. Cohort studies showed that obesity can be tracked from childhood to adulthood. Overweight adults, in turn, have been associated with increased risk of type 2 diabetes mellitus, coronary heart disease, high blood cholesterol, and high blood pressure. These chronic non-communicable diseases contributed to about 60% of all deaths and 47% of the burden of disease across the world.¹

Obesity accounts for 2-6% of total health care costs in several developed countries.¹ According to the UK National Hospital Discharge Survey, from 1979 to 1999, the percentage of discharges with obesity-associated diseases increased dramatically. Obesity-associated annual hospital costs of children (based on 2001 constant US dollar value) increased more than threefold; from \$35 million (0.43% of total hospital costs) during 1979-1981 to \$127 million (1.70% of total hospital costs) during 1997-1999.⁹ The true costs may be much greater as not all obesity-related conditions are included in the calculations.

Definition

Obesity is an excess of adipose tissue. A variety of methods have been developed for measuring the adipose compartment directly. They include underwater weight measurements, dual-energy x-ray absorptiometry, magnetic resonance imaging, computed tomography, and stable isotope techniques. These methods are mostly inconvenient or too expensive for routine clinical use. Skinfold thickness measurements can be performed easily in a clinical setting but are difficult to be accurate in most obese patients. Bioelectric impedance analysis which is also easy to perform and considerably less expensive than the other direct measures of adiposity is a promising method, provided that an appropriate standard is available.¹⁰

Traditionally, obesity has been defined as weight for height above 2 standard deviations or excess weight above 120% of the median for weight given the child's age, height, and gender. Recently body mass index (BMI), body weight (in kilograms) divided by the height (in meters) squared, has been recommended for assessment of obesity in children as it offers continuity for the measure

of adiposity across the lifespan. In addition, BMI correlates well with direct measures of body fatness and with obesity-related co-morbid conditions in adults and children.¹⁰

In adults, BMI cut-off points are convenient whole numbers of 25-29 defining overweight and 30 or above defining obesity. On the contrary, during childhood and adolescence, BMI differs by age, genders, pubertal stage, and ethnicity. Recently the International Obesity Task Force (IOTF) has developed BMI centile curves based on pooled data of children and adolescents aged 2-18 years from 6 countries - Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the USA.¹¹ The IOTF BMI curves used the statistical method to draw centile lines corresponding to a BMI 25 and a BMI 30 at age 18. Thus the IOTF BMI curves provide continuity from childhood into adulthood. Due to possible ethnic differences, the IOTF BMI curves should be validated in children and adolescents from other countries. As the BMI reference for Thai children are not available yet, classification of obesity is thus based on weight for height curves.

Waist circumference, which is easy to measure with no calculations required, is gaining acceptance as a good predictor of obesity-related co-morbidities in adults. Some studies have even suggested that the utility of waist circumference in indicating health risk exceeds that of BMI. Reference data for waist circumference in children are available from some countries e.g. the UK, Spain and the USA.¹² As ethnic differences in intra-abdominal fat mass may exist; a reference for Thai children is being developed by the Institute of Nutrition, Mahidol University under the support of the National Health Foundation and the Thailand Research Fund.

Etiology

Overweight and obesity are a result of energy imbalance over a long period of time. The cause of energy imbalance for each individual is due to a complex interaction of genetics, individual behaviors, and environmental factors.

Studies of twins and adoptees provide evidences that heritability accounts for 30% to 80% of variations in weight. There are about 30 mendelian disorders associated with obesity but often with mental retardation, dysmorphic features and organ-specific developmental disorders such as in the Prader Willi syndrome. From the rodent model of obesity, about 400 genes and a number of neurochemical pathways involved in energy homeostasis have been identified. In humans, even the commonest monogenic cause of obesity, the mutation of Melanocortin 4 receptor (Mc4r) gene, accounts for only 5% of the severely obese patients.¹³ Families with leptin deficiency characterized by severe early onset obesity and intense hyperphagia with dramatic response to leptin administration were also reported.

Maternal nutrition be it under or over has been demonstrated to be associated with obesity in her offspring. A parental high-fat diet before intrauterine development stage can affect body fat accumulation in children. Maternal dietary methionine may induce the epigenetic modification, and some modified epigenetic marker may be transmitted to next generation.¹⁴ On the other hand, poor nutrition early in life can imprint permanent changes in fetal metabolism (fetal programming) and increase the likelihood of obesity in children exposed to accelerated gain in height and weight during middle childhood.¹⁰

The current global epidemic of obesity is too rapid to be associated with major genetic changes. As mentioned above, only a handful of humans worldwide have been shown to have a true "genetic obesity". In the face of

environmental pressures to eat more and move less, one finds it hard to maintain energy balance and resist weight gain. In this way, it is not only human physiology that is abnormal; it is also the evolving environment that is overwhelming the biological regulation of energy balance which leads to obesity.¹⁵

Management

Secondary causes of obesity should be considered and investigated accordingly in obese children with short stature, dysmorphic features or mental retardation.

Fasting lipid profile and fasting glucose should be performed in obese or overweight children. Screening for type 2 diabetes (fasting insulin and hemoglobin A1C, or a glucose tolerance test) is suggested for overweight adolescents having a family history of type 2 diabetes in first- or second-degree relative, signs of insulin resistance or conditions associated with insulin resistance (acanthosis nigricans, hypertension, dyslipidemia, polycystic ovary syndrome). Liver function tests should be obtained because steatohepatitis is generally asymptomatic.⁵

Severely obese children and adolescents, who present with snoring, sleep disturbances, or attention deficit should be investigated for obstructive sleep apnea. Radiological testing is necessary to diagnose slipped capital femoral epiphyses and Blount disease.

Concerns of family members about the child's weight and willingness to make necessary change are important for treatment success. Education about current medical conditions or risks in the family could induce the family to participate. Unrealistic goals concerning weight loss can undermine the child's confidence and reinforce a defeating attitude resulting in dropout and relapse.

The goal of the management is to reach a healthy weight without affecting linear growth. Weight maintenance is always the first goal for the growing child. Moderate to severe obese children with co-morbidities should aim for weight reduction. However, children and their families need to recognize that sustainable weight loss of as little as 5% to 10% results in significant improvement in cholesterol, blood pressure and blood glucose.⁵

The main components of weight management program are diet, physical activity, behavior modification, and a maintenance program. Studies with short and moderate lengths of follow-up have shown benefits from a variety of "lifestyle" interventions, including nutritional education, exercise, and measures to decrease sedentary activity.¹⁰

Nutrition therapy

Dietary recommendations for children with obesity consist of reduction in dietary fat and energy intake as a balanced, hypocaloric diet. Specific recommendations include limiting beverages and foods with high caloric density and low nutritional value, including sugary beverages, full-fat or sweetened milk, sweetened drinking yoghurts, deep fried foods or snacks, full-fat baked foods and candies, and encouraging whole grains, fruits, and vegetables. Simple behavioral measures such as meal planning and label reading can help obese children in adherence to these nutritional guidelines.

A meal plan consistent with the nutrition flag or food guide pyramid is generally recommended. The "traffic light diet" provides a structured, balanced, hypocaloric diet in a simple format which could be followed easily by young children and adolescents at the ambulatory setting. It uses a simple color-coding scheme to categorize foods into categories for free consumption (low caloric density

TABLE 1. Recommended levels of energy density, fat, sugar and sodium in snacks for children.¹⁶

	Portion/day	Portion/meal
Calories* (kcal)	<300	<150
Fat* (g)	<5	<2.5
Sugar+ (g)	<24	<12
Sodium* (mg)	<200	<100

* Recommendation was based on provision of not more than 20% of daily intake as snacks to children aged 2-15 year old using Dietary Reference Intake for Thais 2003. Calculated average energy intake for this age group was 1,350 kcal.

+ Based on the recommended intake of sugar of less than 10% of daily energy intake. Calculated daily sugar intake was less than 135 kcal or 33.75 g. As a portion of sugar was obtained from food, the committee decided to allocate 24 g of sugar to snacks.

foods, green), moderate consumption (moderate caloric density and protein-containing foods, yellow), and very limited consumption (foods with high caloric density and/or with high sugar or fat content, red). The prescribed caloric content of the diet is generally between 900 and 1,300 kcal daily.¹⁰

Self-monitoring of intake may help children learn to eat only when they are hungry and also help them to focus on which foods they choose to eat. In some cases a structured diet, which does not forbid any foods but balances the amount of high and low calorie foods, is appropriate.⁵

In recognition of the important contribution of snacks to child nutrition, the Royal College of Pediatricians of Thailand has recommended guidelines on smart snacks with an emphasis on the caloric density as well as fat, sugar and sodium contents (Table 1).¹⁶

Patients with severe obesity may benefit from strict diets such as the protein sparing modified fast diet (PSMF) which is designed to provide enough protein to minimize loss of lean body mass during weight loss. The patient consumes 600-800 kcal, 2 g/kg/d of protein (maximum 100 g/d), 30-40% of calories as fat, and 10-20% of calories as complex carbohydrates. Benefits of this diet are relatively rapid weight loss (1 to 2 kilograms per week) and anorexia induced by ketosis. Complications include protein losses, hypokalemia, hypoglycemia (particularly in the very young), inadequate calcium intake and orthostatic hypotension. Multivitamin, potassium and calcium supplementation and adequate calorie-free fluid intake (2 L per day) can minimize these complications. Typically, patients start with a hypocaloric diet (1,200 kcal/day) for 2 weeks before the PSMF diet is started; the PSMF diet (600-800 kcal/day) continues for about 12 weeks and is followed by a maintenance diet (balanced, 1,200 kcal/day).¹⁰ The inpatient stay will also provide an opportunity for nutritional education and for engaging the patient and family in a therapeutic plan to address the obesity beyond the hospital stay.

A variety of popular diets have arisen around alterations of specific macronutrients, with or without limitations on total caloric intake, and with or without restrictions on fat or carbohydrate intake. No good quality long-term studies of such diets in children have been carried out yet.

Physical activity and exercise

Any form of increased physical activity is beneficial, provided that activities are age-appropriate, enjoyable and sustainable. For pre-pubertal children, simply increasing

time spent in free play, especially outdoors, is likely to be beneficial. Light exercise such as walking provides valuable family time together and increased caloric expenditure. Aerobic exercise and endurance training increase the ability to oxidize fats. Yet most children find periods of such defined exercise boring and unpleasant and may not continue these activities. Post-pubertal children may benefit from weight training which increases lean body mass and consequently results in increased basal metabolic rate. On the other hand, reducing sedentary behaviors such as limiting television viewing or computer games to 1 or 2 hours per day may be the most effective way to facilitate physical activity and weight loss in children.⁵

Behavior modification

Most successful weight control programs use behavior modification techniques to reduce caloric intake and increase activity. Commonly used strategies to change behavior include modification of the environment to decrease stimuli for eating or inactivity, self-monitoring of eating and activity, behavioral contract and positive reinforcement for new behaviors.¹⁷ Behavior therapy should be thought of as a tool to achieve long term changes in diet and exercise.

Family Involvement⁵

Treating the overweight involves understanding the eating and activity habits of the entire family. Changing these habits demands considerable effort and support. All family members including parents, grand parents, and other caregivers, need to provide access to healthy, nutrient-dense foods and snacks and opportunities for the child to increase physical activity. They can reinforce positive eating and activity behaviors with rewards not based on food, money or gifts. Rewards are generally recommended for diet and physical activity change rather than for weight loss. A typical reward could involve praise or quality family time. Parents can increase a child's self-esteem by giving the child positive, supportive messages that promote learning, decision making and self-confidence.

Pharmacological Treatment

Pharmacological treatment should be reserved for morbidly obese adolescents. The two anti-obesity drugs most carefully studied in obese adolescents are orlistat and sibutramine. In clinical trials of these drugs, subjects also received education and behavior modification to increase physical activity and decrease caloric intake. Both drugs induced a modest weight loss.

Orlistat, an enteric lipase inhibitor, blocks absorption of approximately 30% of dietary fat. The recommended dose of orlistat is 120 mg three times per day with meals. At the end of the 54th week of a randomized, double-blind study of 539 obese adolescents (aged 12-16 years; body mass index [BMI] ≥ 2 units above the 95th percentile), BMI had decreased by 0.55 with orlistat but increased by 0.31 with placebo (P = 0.001). Gastrointestinal tract adverse events occurred more frequently in the orlistat group (9% to 50%) than in the placebo group (1% to 13%).¹⁸ Fat-soluble vitamins should also be taken because orlistat can reduce their absorption.

Sibutramine suppresses appetite by inhibition of serotonin and noradrenaline reuptake. Sibutramine added to a behavior therapy program reduced BMI and body weight more than the placebo and improved the profile of several metabolic risk factors in obese adolescents. In a randomized, double-blind, placebo-controlled trial of 498 adolescents aged 12 to 16 with a BMI > 2 units, subjects

received 10 mg of sibutramine or placebo. Sibutramine was uptitrated to 15 mg at month 6 if initial BMI was not reduced by 10%. Its use resulted in an average weight loss of 8.4 kg [95% CI: -9.7 to -7.2 kg] over 12 months. However, tachycardia was found 6.3% more common in the sibutramine group.¹⁹

Gastric Bypass Surgery

There are few data on bariatric surgery in obese adolescents and none in younger children. Until more data are available in children, gastric bypass surgery should be considered only for well-informed and motivated adolescents who meet the following criteria: severe obesity (BMI >40), failure of >6 months of organized attempts at weight loss, near-complete skeletal maturity and significant co-morbidities that would be responsive to sustained weight loss. As in adults, a multidisciplinary team with medical, surgical, nutritional and psychological expertise carefully selects adolescents for gastric bypass. Extensive counseling, education and support are required both before and after gastric bypass. Only a surgeon with extensive experience with bariatric surgery should perform gastric bypass surgery. Finally, adolescents undergoing gastric bypass require lifelong medical and nutritional surveillance, especially during pregnancy.⁵

Prevention

Treatment for childhood obesity remains largely ineffective and long-term weight loss has proven exceedingly difficult to achieve. In adults, most of the weight loss is regained within a year, and virtually all is regained within 5 years. The relative intellectual and psychological immaturity of children compared with adults, and their susceptibility to peer pressure present additional obstacles to the successful treatment.⁵ Thus, the most logical approach to solve obesity in childhood is prevention.

In early childhood, child weight reflects the eating and activity environment provided by parents or other caregivers. While in school, a child can be influenced by what is taught about diet and activity as well as what is offered for meals and exercise. Habits that develop in childhood profoundly influence activities later in life. For this reason, most efforts to reduce obesity in children have used either family-based programs or school-based approaches.¹⁵ However, a meta-analysis of 22 such interventions suggests that increased physical activity and dietary changes, singly or in combination, are not effective in preventing weight gain, but can be effective in promoting a healthy diet and increased physical activity levels.²⁰

There is increasing recognition that obesity is not just a personal responsibility, but a societal issue. Children even when supported by home and school cannot be expected to counter the many subtle and usually well-resourced influences - from the media, on food labels, in the supermarkets and restaurants, and among their peers - which encourage obesity. In order to oppose this strong current, population-based activities are needed to deal with these up-stream risk factors. The desirable public policies will have to be large in scale and encompass both commercial and social activities, such as agricultural support policies, food industry investment strategies, taxation and subsidy measures, road transport planning and street crime reduction schemes along with education and health promotion initiatives.²¹

For Thailand, several policy movements to prevent child obesity have been in progress. For example, since April 2006 added sucrose was no longer allowed in follow-

on infant formula. Other current activities include snack labeling, a reduced amount of added sugar in commercial cereal based infant foods, a ban of soft drink and energy-dense/nutrient-poor snacks in school grounds, integrating healthy eating into school curriculum, increasing vegetable and fruit in school meals, increasing exercise opportunities for students, controlling advertising and marketing activities to children, and taxation of sugary goods. Some measures may be unpopular. To be put into practice, one may have to use media and public relations to mobilize social movements, in order to gain commitment from political and commercial sectors. Otherwise the obesity problem in children and hence the non-communicable disease burden in adults might be out of control and lead to a public health crisis in the near future.

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