

## **Childhood Obesity: Contributing Factors, Consequences and Intervention**

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### **ABSTRACT**

Childhood obesity has been growing at an alarming rate and is the most common nutritional problem among children in developed as well as in developing countries. It is associated with significant morbidity and mortality, including cardiovascular, respiratory, gastrointestinal, endocrine and psychosocial morbidities. This unhealthy trend will progress to adulthood and is expected to lead to huge economic costs in health and social security systems. Among the many factors which contribute to the increasing prevalence of childhood obesity include environment and genetic factors. This paper discusses the aetiology, consequences and necessary interventions for this problem.

### **INTRODUCTION**

Obesity is the most common nutritional problem among children in developed countries (Sorof & Daniels, 2002). It is a complex, multifactorial and chronic condition resulting from an interplay between environment and genetics (Segal & Sanchez, 2001). The prevalence of obesity has been growing at an alarming rate for decades in both children and adults (Giammattei *et al.*, 2003). Obesity prevalence is 14–20% in industrialised countries, but the fastest increases, particularly in childhood obesity, are seen in developing countries such as Chile and China (Finer, 2003). Worldwide, 22 million children under the age of five are overweight (Finer, 2003).

Obesity is associated with significant morbidity and mortality, including cardiovascular, respiratory, orthopedic, gastrointestinal, endocrine, and psychosocial morbidities (Segal & Sanchez, 2001). As increasing numbers of overweight children and adolescents progress to adulthood, these complications are expected to reach epidemic proportions (Segal & Sanchez, 2001).

Being an overweight child under 3 years of age, does not predict future obesity unless at least one parent is also obese. After the age of 3 years, the likelihood that obesity will persist into adulthood increases with advancing age of the child and is higher in children with severe obesity in all age groups. After an obese child reaches 6 years of age, the probability that obesity will persist into adulthood exceeds 50%, and 70%–80% of obese adolescents will remain so as adults (Segal & Sanchez, 2001).

Worldwide, the adoption of industrialised western society lifestyles (urbanization, western foods, increased sedentariness and car ownership) is associated with increasing obesity. The shift towards a 'westernized' dietary pattern has brought about a new nutrition scenario in many developing countries. These countries are now faced with the twin problems of malnutrition i.e. under nutrition among some segments of the communities and the problems of obesity and associated disorders in other groups (Tee, 1999).

In Malaysia, rapid and marked socio-economic advancement over the past two decades has brought about significant changes in the lifestyles of communities. These include significant changes in the dietary patterns e.g. an increase in consumption of fats, oils and refined carbohydrates and a decreased intake of complex carbohydrates. This has resulted in a decline in the proportion of energy from carbohydrates, while an increase in the percentage contribution of fat has been observed (Tee, 1999).

Changes in meal patterns are also evident: more families eat out, busy executives skip meals, and younger generations miss breakfast and rely too much on fast food. In addition, communities have become generally more sedentary (Tee, 1999). All these changes have brought about undesired effects with significant proportions of the population being afflicted with various non-communicable diseases associated with over nutrition, namely obesity, hypertension, coronary heart disease, type II diabetes and cancers (Tee, 1999).

## **EPIDEMIOLOGY OF CHILDHOOD OBESITY**

Childhood obesity is already an epidemic in some areas and on the rise in others. An estimated 17.6 million children under five are overweight worldwide (WHO, 2003). The prevalence of obese children aged 6 to 11 years old has more than doubled since the 1960s (WHO, 2003). A national survey conducted in USA from 1988 to 1994 found over 20% of children aged 12 to 17 years overweight with 10% of 6 to 12-year-old children been overweight (Segal & Sanchez, 2001).

The problem of childhood obesity is global and extends into the developing world: for example, in Thailand the prevalence of obesity in 5–12 year-old children has increased from 12.2% to 15.6% in just two years (WHO, 2003). The prevalence rate of childhood obesity in China reached 7.1% in Beijing and 8.3% in Shanghai in year 2000 (WHO, 2000a). The rate rose with age, from 3.7% among 3-year-olds to 11.7% among 6-year-olds (WHO, 2000b).

In Malaysia, obesity has increased from 1% in 1990 to 6% in 1997 among 13 to 17-year-olds (Ismail & Vickneswary, 1999). A survey done by Ismail & Tan (1998) has also demonstrated increasing prevalence of obesity with increasing age: 6.6% among 7-year-olds, rising to 13.8% among 10-year-olds. Obesity among these 7 to 10-year-olds was higher among boys than girls (12.5% compared to 5%). Ethnic differences were also found, especially among boys, with 16.8% of Malays being obese compared to approximately 11.0% of Chinese and Indians (Ismail & Tan, 1998)

Another study among school children (6 239 respondents) aged between 7 to 16 years in Kuala Lumpur by Kasmini *et al.* (1997) found that prevalence of obesity and overweight were 3.5% and 6.0% respectively. Males were found to be more obese than females. Most children were found to be overweight and obese around the puberty period (between 11 to 14 year old) (Kasmini *et al.*, 1997). However, ethnic differences in this study were not similar to the study by Ismail & Tan (1998). There were more overweight children amongst the Indians followed by the Chinese and Malays in this study. Indian males were more obese, Chinese males more overweight, Chinese females more obese and Indian females more overweight (Kasmini *et al.*, 1997).

## **BODY MASS INDEX (BMI) AS A MEASURE FOR OVERWEIGHT AND OBESITY**

The measurement of overweight and obesity in children and adolescents pose particular problems due to differences in maturation and growth. Adiposity measures are linked to a child's stage of maturation at the time of measurement and there are two periods when adiposity increases – about the age 5-7 years, and early puberty. Although a fixed cut-off rate can be used to define obesity in adults, this needs to be adjusted for age in childhood. Some countries have their own charts for calculating weight, height and obesity for age e.g. Singapore (WHO, 2000b).

BMI in childhood changes substantially with age. At birth the median is as low as 13kg/m<sup>2</sup>, increasing to 17kg/m<sup>2</sup> at age 1, decreasing to 15.5kg/m<sup>2</sup> at age 6, then increasing to 21 kg/m<sup>2</sup> at age 20. Clearly, a cut-off point related to age is needed to define child obesity (Cole *et al.*, 2000). Recently an agreement has been reached on appropriate measures for adiposity which allows classification and comparison (Segal & Sanchez, 2001). The BMI for age chart is recommended. Those over the 95<sup>th</sup> percentile are considered obese, whilst those over the 85<sup>th</sup> percentile of BMI for age are 'at risk' (Segal & Sanchez, 2001; WHO, 2000b).

The International Obesity Task Force is developing an international standard BMI for age which should be available in the near future. In this chart, the 85<sup>th</sup> percentile and the 95<sup>th</sup> percentile roughly correspond to BMIs of 25 kg/m<sup>2</sup> and 30 kg/m<sup>2</sup> respectively in 18-year-olds (WHO, 2000b).

## **CONTRIBUTING FACTORS**

Obesity is caused by an imbalance in energy input versus output, resulting in a positive energy balance. The positive energy balance needed for obesity to develop is so small that individuals usually do not notice consuming it. Just 10 calories per day in excess of what the body requires for weight maintenance will produce a 1 pound (1Kg = 2.2 lbs) weight gain over one year (Segal & Sanchez, 2001). However, there are many other contributing factors of obesity in childhood as discussed in the ensuing paragraphs.

### **Genetics**

In the general population, genetic factors play a role in the risk of obesity development (Koletzko *et al.*, 2002). Many researchers believe that genetics plays a strong role in determining whether an individual has weight problems. Studies have found a correlation between parent and child obesity, although such a correlation may be due either to genetic or common environmental factors, because the family shares both. More likely, genetics determines whether one is susceptible to the disease of obesity (Anderson *et al.*, 2003).

Pediatricians are well aware of genetic defect leading to syndromic obesity, such as those found in patients with Laurence Moon Bardet Biedl syndrome, Prader Willi syndrome, Trisomy 21, Wiedemann Beckwith syndrome, and others. Recently, other specific, monogenetic disorders have been identified as rare causes of obesity beginning in early childhood (Koletzko *et al.*, 2002).

### **Environmental factors**

#### *Effect of television viewing*

Children who spend more time watching television have a higher BMI and a higher percent of body fat and are less physically active (Giammattei *et al.*, 2003). Watching television can decrease the amount of time spent performing physical activities and has also been associated with increased food consumption either during viewing or as a result of food advertisements. It has been reported that children are spending more time in front of the television, watching television and playing video games, than doing any other activities besides sleeping. An increase in dietary energy intake combined with decreased energy expenditure contributes to weight gain (Anderson *et al.*, 2003; Giammattei *et al.*, 2003).

Another study in California, conducted in 2000–2001, involving 385 sixth and seventh grade students (11 to 13 years old) concluded that time spent watching television was significantly associated with obesity (Giammattei *et al.*, 2003).

#### *Fast foods and soft drink consumption*

Fast food consumption is another leading suspect in the childhood obesity epidemic. Fast food typically includes all of the things that nutritionists warn against: 'saturated and trans fats', high glycaemic index, high energy density, and large portion sizes. A large fast food meal can contain about 2 200 calories, which at a burn rate of 85–100 calories per mile would require something near a full marathon to expend (Anderson *et al.*, 2003). Sweetened soft drinks contain empty calories and contribute to the total caloric intake, which is an important contributing factor to the rise in adolescent obesity (Giammattei *et al.*, 2003).

#### *Home factors*

There are several potential mechanisms through which children's eating patterns and level of physical activity may be affected by having parents who work outside the home. Child care providers may be more likely than parents to offer children food that is highly caloric and of poor nutritional value, perhaps because they are more concerned with placating their wards than

with their long term health. Further, parents who work outside the home may serve more high calorie prepared or fast foods because of time constraints. Additionally, unsupervised children may make poor nutritional choices when preparing their own snacks (Anderson *et al.*, 2003).

### *School factors*

In the US, over 50% of children get breakfast or lunch from a school meal programme and over 10% get both. Thus, there is a great deal of scope for children's diet to be influenced by food they have access to in schools (Anderson *et al.*, 2003). There is evidence that the food that schools serve matters for what children consume. For example, making more low fat foods available to children in school reduces the amount of fat they consume. In addition to school meals, however, children may have access to a wide variety of snack foods and drinks through vending machines, school stores and fundraisers. Research suggests that this access has an impact on children's diet as well (Anderson *et al.*, 2003).

### **Effect of maternal smoking during pregnancy**

A cohort study conducted by Von Kries *et al.* (2002) concluded that maternal smoking during pregnancy might be a risk factor for childhood obesity. The main finding of this study was the higher prevalence of overweight and obesity in children of mothers who smoked during pregnancy (Von Kries *et al.*, 2002).

The association between maternal smoking during pregnancy and childhood obesity may appear surprising with respect to the known association of maternal smoking during pregnancy and low birth weight. A tempting explanation for the observed findings could be the recently described impact of catch-up growth in the first year of life on childhood obesity (Von Kries *et al.*, 2002). Such data have shown that children with catch-up growth had a considerably higher body mass index, skin fold thickness, and waist circumference at the age of 5 years. During the first year of life, there is rapid catch-up growth in relation to weight in children of mothers who smoke during pregnancy. A high weight gain was associated with an increased risk of overweight and obesity (Von Kries *et al.*, 2002).

### **Effect of breastfeeding**

A study done by Von Kries *et al.* (1999) in Southern Germany in 1997 involving 134 577 children has shown that the risk of obesity in children can be reduced by breastfeeding, with a 35% reduction if children are breastfed for 3 to 5 months (Von Kries *et al.*, 1999).

A recent survey also found that the prevalence of obesity in children who had never been breastfed was 1.6-fold higher than in previously breastfed children (Koletzko *et al.*, 2002). The survey also found that breastfeeding remained a protective factor against the development of overweight and obesity. Thus, promoting prolonged breast feeding may help decrease the prevalence of obesity in childhood (Koletzko *et al.*, 2002).

There was significantly higher plasma concentration of insulin in infants who had been bottlefed compared to infants who had been breastfed. These higher concentrations stimulate fat

deposition and the early development of adipocytes. Breast milk also contains bioactive factors which may modulate the epidermal growth factor and tumour necrosis factor, both of which are known to inhibit adipocyte differentiation *in vitro* (Von Kries *et al.*, 1999).

## **CONSEQUENCES OF CHILDHOOD OBESITY**

Many of the outcomes associated with obesity that were previously thought of as diseases of adults are now affecting children as well. Outcomes related to childhood obesity include hypertension, type II diabetes mellitus, dyslipidemia, left ventricular hypertrophy, nonalcoholic steatohepatitis, obstructive sleep apnea, and orthopedic problems (such as slipped capital-femoral epiphysis), as well as social and psychological problems (Sorof & Daniels, 2002).

### **Cardiovascular risk factors**

Most of the major cardiovascular risk factors associated with childhood obesity are high blood pressure, dyslipidemia, and abnormalities in left ventricular mass and/or function, abnormalities in endothelial function and hyperinsulinaemia and/or insulin resistance (Reilly *et al.*, 2003). Many studies have observed significant ‘clustering’ of cardiovascular risk factors with paediatric obesity, and it has become clear that the extent of asymptomatic atherosclerotic lesions in childhood and adolescence is predicted by the number of cardiovascular risk factors present. In summary, it is now well established that childhood obesity has adverse effects on the cardiovascular system which are similar to those well known in adults (Reilly *et al.*, 2003).

### **High blood pressure**

Once considered rare, primary hypertension in children has become increasingly common in association with obesity and other risk factors, including a family history of hypertension and an ethnic predisposition to hypertensive disease. Obese children are at approximately 3-folds higher risk for hypertension than non-obese children (Sorof & Daniels, 2002).

### **Dyslipidaemia**

A study done by Freedman, Dietz & Srinivasan (1999) reported that there was raised LDL cholesterol, lowered HDL cholesterol and raised triglycerides among children and adolescents. The same study also found that 58% of obese 5 to 10-year-olds had at least one cardiovascular risk factor, and 25% had two or more risk factors (Freedman *et al.*, 1999).

### **Risk of type II diabetes mellitus**

A study among 710 grossly obese Italian children, aged 8–16 years, who underwent an oral glucose test conducted by Invitti *et al.* (2003) concluded that in these grossly obese children, both insulin resistance and impaired insulin secretion contributed to glycemia (Invitti *et al.*, 2003).

Another study by Sinha *et al.* (2002) found that impaired glucose tolerance is highly prevalent among children and adolescents with severe obesity. The study suggested that insulin resistance, initially associated with hyperinsulinemia and hyperproinsulinemia is the most important factor linked to the development of impaired glucose tolerance in severe childhood obesity (Sinha *et al.*, 2002).

Another survey among obese children and adolescents in a northern Canadian aboriginal community found that the early onset of type II diabetes in childhood is increasingly observed in many populations where childhood obesity is a strong risk factor (Young *et al.*, 2000).

### **Risk of newly diagnosed asthma**

Asthma is a large and growing threat to children's health and well-being. An emerging body of evidence suggests that obesity may play a role in the development of childhood asthma through the non-allergic pathway (Gilliland *et al.*, 2003). It has been recognized that obesity is more common among children with asthma, and the association between asthma and high body mass index (BMI) has been observed in studies of adults and children (Gilliland *et al.*, 2003).

The observed association between asthma and obesity may be explained by the fact that these asthmatic children usually lack physical activity. In girls, becoming overweight or obese between the ages of 6 and 11 years has been found to increase the risk of developing new asthma and to increase bronchial responsiveness during adolescence (Gilliland *et al.*, 2003). A cohort study conducted by Gilliland *et al.* (2003), involving 3 792 participants in the Children' Health Study (Southern California) between 1993 and 1998 concluded that being overweight is associated with an increased risk of new onset asthma in boys and in non-allergic children. It is associated with a lack of physical exercise and a diet high in calories. This study suggests that activity levels and dietary habits may be related to the onset of childhood asthma. Thus, some aspect of the lifestyles associated with obesity, such as more time spent indoors, may be the aetiological important factor for new onset asthma in some communities (Gilliland *et al.*, 2003).

Another suggestion is that obesity may enhance non-eosinophilic inflammatory pathways that increase the risk of non-atopic asthma. Obesity and weight change have also been prospectively associated with increased bronchial hyper-responsiveness in asthmatic children as well as in non-asthmatic children. The combined effect of increased bronchial hyper-responsiveness and the pro-inflammatory milieu in obese subjects may set the stage for the onset of asthma (Gilliland *et al.*, 2003).

### **Risk of psychosocial problems**

Psychosocial problems can also be a problem in children with obesity, as their weight can be seen by them and others as a significant handicap. It has been suggested that adults who have been obese since childhood are more likely to suffer from psychological disturbances and that adolescence may be the period of greatest risk (WHO, 2000a).

An article about psychological consequences of obesity by Reilly *et al.* (2003) found that obese children are more likely to experience psychological or psychiatric problems than non obese

children, that girls are at greater risk than boys, and that risk of psychological morbidity increases with age. Low self-esteem and behavioural problems were particularly commonly associated with obesity (Reilly *et al.*, 2003).

An article about decreased quality of life associated with obesity in school-aged children showed that children who are overweight have two to four times increased odds of having low scores for psychosocial health, self-esteem, and physical functioning (Friedlander *et al.*, 2003). Another study also found that obese children and adolescents reported significant impairment in physical, psychosocial, emotional, social, and school functioning, which was 5.5 times greater than that for healthy children or adolescents (Schwimmer *et al.*, 2003).

### **Risk of metabolic syndrome**

A population based study done in 1993-94, Finland by Vanhala *et al.* (1998) concluded that half of the obese children had become obese adults, with an especially high risk of metabolic syndrome and that childhood obesity increases the risk for metabolic syndromes in adulthood. The risk of the syndrome was lower among the obese adults who had not been obese as children compared to obese adults who had also been obese as children (Vanhala *et al.*, 1998).

The finding suggests that obesity in adulthood that was established in childhood may be more harmful than obesity that has appeared in adulthood. The possible mechanism is that continuous obesity from childhood to adulthood serves as a 'generator' for prolonged insulin resistance, which results in the clustering of hypertension and metabolic abnormalities in the same individual (Vanhala *et al.*, 1998).

## **INTERVENTIONS**

The ultimate strategy towards achieving a healthy nation is the promotion of a healthy lifestyle. The promotion of a healthy lifestyle include promoting healthy eating habits and maintaining a desirable dietary pattern (Tee, 1999). Various programs and interventions have been carried out by developed and developing countries including Malaysia to ameliorate the nutritional problems seen in the country (Tee & Cavalli-Sforza, 1993).

Due to the increasing trend of non-communicable diseases in this country, the Ministry of Health launched several campaigns for the promotion of healthy lifestyles among Malaysians. As for addressing childhood and adolescent nutritional problems, the Ministry of Education also launched the School Health Program and the "School Canteen Guideline" to protect, promote and maintain optimum health of pupils and school personnel, promote healthy school living and develop desirable knowledge, attitudes and practices pertaining to health (Tee, 1999).

The Healthy Lifestyle Campaign was launched in May 1991 with its first thematic campaign, i.e. cardiovascular diseases. Other campaigns included food safety (1993), childhood diseases (1994), cancers (1995) and diabetes mellitus (1996). These programmes focused on creating awareness and educating the public with regards to these diseases (Tee, 1999). The Ministry of Health Malaysia then implemented another series of activities under the theme "Healthy Eating"

carried out under the second phase of the Healthy Lifestyle Campaigns (1997-2002). The Healthy Eating Campaign focused on four main topics with emphasis on dietary practices, body weight, food and nutrition labeling as well as food hygiene. The food pyramid was also introduced for the first time in the country, based on 4 layers and 5 food groups and serving sizes appropriate for local populations (Tee, 1999).

The Ministry of Health also identified various organizations such as Radio and Televisyen Malaysia, the Education Ministry, food related agencies, as well as professional bodies such as Malaysian Dietitian Association and Nutrition Society of Malaysia for collaboration in order to disseminate the Healthy Eating messages. A knowledge, attitude and practice (KAP) study of food and nutrition among the various target groups was carried out to obtain baseline data (Tee, 1999).

## **CHALLENGES TO THE IMPLEMENTATION OF THE HEALTHY LIFESTYLE CAMPAIGNS**

Malaysians have now become more health conscious. The challenge now is to implement nutrition education programs where nutritionists are trained to carry out these activities as well as other nutrition intervention programs. To ensure the success of these programs, the number of nutritionists graduating from universities needs to be increased and special training on childhood and adolescent nutrition with emphasis on obesity needs to be addressed. Continuing education of existing staff also needs to be adequately addressed on these aspects (Tee, 1999).

The important issue is to arrest the increase in these diet-related chronic diseases from an early age. Changes in dietary patterns of Malaysians towards an 'affluent' diet of the developed industrialized countries especially among children and adolescents are a cause for concern. The challenge to nutritionists and other health workers is to examine and implement ways for communities to maintain a balanced nutrition.

## **MANAGEMENT OF CHILDHOOD OBESITY**

The Ministry of Health Malaysia and Academy of Medicine Malaysia (2003) have recently come out with clinical practice guidelines on the management of obesity. The components of obesity management in children and adolescent recommended in these guidelines are:

- Reduction of energy intake by dietary modification, and using conventional foods
- Increased energy expenditure by increasing physical activities and decreasing physical inactivity
- Behaviour modification associated with eating habits and activity pattern
- Involvement of the family in the process of change

However, the best way to significantly affect the prevalence is to prevent it. Tips for parents towards prevention of obesity in childhood are:

- Respect the child's appetite: children do not need to finish every bottle or meal
- Avoid pre-prepared and sugared foods when possible
- Limit the amount of high calorie foods kept in the home
- Provide a healthy diet, with 30 percent or fewer calories derived from fat
- Provide ample fiber in the child's diet
- Skimmed milk may safely replace whole milk at 2 years of age
- Do not provide food for comfort or as a reward
- Do not offer sweets in exchange for a finished meal
- Limit hours of television viewing and computer games
- Encourage active play
- Establish regular family activities such as walks, ball games and other outdoor activities

The currently available pharmaco-therapeutic agents and surgery generally have no place in the management of childhood obesity. When a child does develop obesity, a serious attempt to treat it should be undertaken (Ministry of Health & Academy of Medicine Malaysia, 2003).

## CONCLUSION

Obesity is considered a global epidemic because its prevalence and severity in both adults and children is increasing worldwide at alarming rates. This increase has been related to an increasing sedentary lifestyle with less physical activities as well as changing dietary habits, which occur not only in affluent countries, but also in developing countries and in countries in economic transition. One consequence is that overweight and obesity are becoming the most prevalent childhood nutritional disorders in many parts of the world. As a result, more children experience severe psychosocial burdens and health risks, and because most obese children grow into obese adults, this trend is expected to lead to huge economic costs to health and social security systems (Koletzko, 2002).

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