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Childhood and Adolescent Obesity



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HUMAN

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ABSTRACT

Childhood and Adolescent obesity is on the rise in both industrialized and developing countries. Overweight in children and adolescents is associated with a host of psychological and social problems such as reduced school and social performance, less favorable quality of life, societal victimization and peer teasing, lower self-and body-esteem and neuropsychological dysfunctioning. Obesity is a well-defined term in adults but in children and adolescents, its definition is less consistent. Overweight in children and adolescents may be associated with a host of psychological and social problems, which can have a considerable deleterious impact on the psychological development and quality of life of the overweight youngsters. The need for evidence-based treatment recommendations is a critical health care issue because obese children and adolescents are at risk for developing many of the comorbidities seen in obese adults. In contrast to community populations, elevated rates of psychopathological disturbances, primarily depression, anxiety, somatoform disorders and eating disorders, are usually reported in clinical populations of overweight youngsters.

INTRODUCTION

Obesity is a multi-factorial condition with wide ranging causes including genetic, social, cultural and behavioural factors, all of which may interact. Obesity is a well-defined term in adults but in children and adolescents, its definition is less consistent. The US Center for Disease Control (CDC) growth charts include gender-specific body mass index (BMI) for age growth charts for ages 2 to 19 years. Obesity among individuals 2–19 years old is defined as the 95th percentile or greater of BMI-for age, and overweight is defined as the 85th percentile or greater, but less than the 95th percentile of BMI-for age. Because of the likelihood of stigmatization associated with the term “obesity”, several leading authorities in the field have suggested to define a “risk for overweight” as BMI between 85-95% and overweight as a BMI > 95% (1)

Worldwide, obesity trends are causing serious public health concern and in many countries threatening the viability of basic health care delivery. It is an independent risk factor for cardiovascular diseases and significantly increases the risk of morbidity and mortality. (2)

The effects of overweight and obesity are widely recognized as one of leading health concerns, involving all age and socioeconomic groups. Physiologically, body weight is regulated through a complex system involving interactions between the various components of energy balance, together with feedback mechanisms that regulate appetite, energy intake and energy expenditure. In individuals, excess weight results from prolonged energy imbalance, with the excess energy stored as body fat. In overweight and obesity, ‘excess body fat has accumulated to an extent that is likely to be detrimental to health’ (WHO 2000). Being overweight or obese is strongly associated with several chronic diseases including type 2 diabetes mellitus, cardiovascular disease, some cancers, with mental health and eating disorders. The causes of overweight and obesity are complex. Diet and physical activity are central to energy balance but are directly and indirectly influenced by a wide range of social, environmental, behavioural, genetic and physiological factors. For many individuals, weight gain is hard to avoid and very difficult to reverse. People often have unrealistic expectations of how much weight loss is feasible, which can be reinforced by media reports of weight loss ‘success stories’(2).

Worldwide, disease profiles are transforming at a rapid pace catching the attention of medical professionals and policy makers alike. This is particularly true in low and middle-income

countries that form the major chunk of global population. The emerging epidemics of obesity, cardiovascular disease (CVD) and diabetes form the crux of this phenomenal change. Among these entities, obesity has become a colossal epidemic causing serious public health concern and contributes to 2.6 million deaths worldwide every year¹. Obesity is an independent risk factor for CVD. Obesity is associated with an increased risk of morbidity and mortality as well as reduced life expectancy. The last two decades of the previous century have witnessed dramatic increase in health care costs due to obesity and related issues among children and adolescents⁽³⁾.

Increasing rates of overweight and obesity have reached epidemic proportions in developed countries and are rapidly increasing in many middle-income and less-developed countries⁽⁴⁾. The proportion of children in the general population who are overweight and obese has doubled over the past two decades in developed and developing countries including India^{5,6} and have a rising prevalence of diabetes.^(7,8) Childhood obesity increases the risk of adult obesity as well as chronic health problems such as type II diabetes, hypertension and cardiovascular disease^(9,10). Obesity and overweight have become a global epidemic, and it is still increasing in both industrialized and developing countries⁽¹¹⁾. Obesity and overweight are an increasingly prevalent nutritional disorder among children and adolescents in the world^(12,13). Numerous health risks have been associated with adolescent overweight, including hypertension, respiratory disease, several orthopedic disorders, diabetes mellitus and elevated serum lipid concentrations⁽¹²⁾. Due to the difficulty of curing obesity and over weight in adults and the many long-term adverse effects of childhood obesity, the prevention of childhood obesity has been recognized as a public health priority⁽¹⁴⁾. Increasing evidence shows that childhood obesity and overweight have a profound influence on morbidity and mortality in adult life⁽¹⁴⁻¹⁶⁾.

Sedentary behavior and physical activity in children may be predictive of body mass in late adolescence. Sleeping habit in afternoon, decreased sports and exercise have also been implicated in childhood obesity because they reduce resting metabolism results in reduction of physical activity. A change in the volume of daily physical activity may account for imbalance between energy intake and energy expenditure⁽¹⁷⁾. Physical activity among children has been related to obesity through different mechanisms⁽¹⁸⁾. Reduced levels of physical activity may also lead to lower energy expenditure, thus affecting resting metabolic rate and total energy expenditure.

PHYSIOLOGY OF WEIGHT GAIN:

All components of energy balance, including energy intake and expenditure, interact with each other to affect body weight. The body attempts to maintain energy balance and protect existing body weight through a complex negative feedback system involving hormones that:

- increase hunger (e.g. ghrelin)
- inhibit food uptake in the short term (e.g. cholecystokinin, PYY, oxyntomodulin, amylin, GLP1)
- inhibit food intake in the long term (e.g. leptin and insulin)
- increase metabolic rate and energy expenditure (e.g. triiodothyronine [T3]).

This system responds to changes in body fat and other energy stores by modulating appetite, energy intake and energy expenditure, with the aim of maintaining body weight at a relatively constant level over time. While this system defends against weight gain as well as weight loss under normal circumstances, energy balance cannot be maintained when an energy surplus is sufficiently large and sustained. Weight gain will begin and usually continue until new weight results in increased energy expenditure and energy balance is re-established. The same physiological mechanisms then seek to maintain energy balance at the higher weight and will defend against weight loss by increasing appetite Sumithran *et al.* 2011, (19) and reducing energy expenditure Rosenbaum *et al.* 2008, (20) if there is an energy deficit. as a result, most overweight and obesity results from upward resetting of the defended level of body weight, rather than the passive accumulation of excess body fat.

Physiological responses are directly and indirectly influenced by a wide range of factors, including inherited biological factors and early life experiences, as well as behavioural, environmental and social factors that influence individual behaviours. The relationships between these factors are complex and not yet fully understood.

BIOLOGY OF WEIGHT GAIN:

Inherited biological factors and early life experience explain why some individuals are more at risk of becoming overweight and obese than others:

Inheritability— one of the strongest predictors of a child's weight is the weight status of his or her parents. The shared family environment is important, but studies of adopted children and monozygotic twins suggest a strong role of genetics in weight status. The inheritance of obesity is thought to result from a large number of genetic variations leading to a series of small but important disruptions to the way the body regulates energy balance Farooqi & O'Rahilly 2007, (21). Genetic variation linked with obesity risk appears to operate, in part, through accelerated growth in early childhood Belsky *et al.* 2012. (22)

Epigenetic changes— alterations in gene expression can be brought about by a range of factors that usually occur in association with intrauterine growth restriction. It is thought that these changes can predispose individuals to obesity by influencing the way energy balance is regulated (Campión *et al.* 2009) (23), and that this predisposition may be expressed in subsequent generations without inheriting the direct genetic variation or continuing exposure to poor nutrition Gluckman *et al.* 2007(24).

Early life experience— the environment in utero and early in life has significant effects on how the body regulates energy balance and stores fat. Poor maternal nutrition during pregnancy increases the risk that offspring will develop metabolic syndrome (a combination of cardiovascular risk factors, including obesity, glucose intolerance and insulin resistance, dyslipidaemia, microalbuminuria and hypertension) (Bruce & Hanson 2010) (25).

Low birth weight infants have an increased tendency to develop abdominal obesity and early metabolic disease, especially when they are exposed to over-nutrition in childhood. Low birth weight is common among women who smoke during pregnancy and smoking is also associated with a 50% increase in the risk of childhood obesity (Oken *et al.* 2008) (26).

Women who gain more than the recommended levels of weight during pregnancy are at greater risk of gestational diabetes and a high birth weight infant. Such children have a greater rate of obesity later in childhood (Gillman *et al.* 2003)(27).

Accelerated weight gain during the first weeks or months of life is associated with higher BMI or obesity later in life. Infants with more rapid early growth have a higher risk of later obesity than infants with normal growth (Baird *et al.* 2005)(28).

Exclusive breastfeeding for a period of at least six months is associated with a reduced level of obesity in childhood, adolescence and early adulthood.

FACTORS AFFECTING INDIVIDUAL BEHAVIOURS

Individual factors

Lifestyle and habits— individuals are not always indirect cognitive control of behaviours related to eating and physical activity. Particular behaviours can become habits if they are repeated often over time so that they become almost an automatic response to certain cues or situations. Once habits are formed, they are difficult to change (Vandenbroeck 2007) (29). Eating and activity habits are often related to increased energy intake, and as environments become more obesity promoting, the behaviours that contribute to overweight and obesity are progressively the default ones.

Psychological factors— stress and underlying personal issues can lead to a lack of energy and motivation and increased food consumption (e.g. emotional or comfort eating), which may indirectly contribute to weight gain. There is a strong association between mood disorders and obesity; people with obesity are more likely to become depressed over time, and people with depression are more likely to become obese. Obesity may increase risk factors for depression such as body dissatisfaction and low self-esteem (Luppino *et al.* 2010) (30). In turn, depression and poor body image can affect people's ability and willingness to eat healthily and exercise regularly. Disturbed eating patterns and eating disorders are also associated with increased risk of both obesity and depression (Luppino *et al.* 2010). People with serious mental health issues (bipolar disorder, schizophrenia) may also be at greater risk of developing obesity, particularly if they take antipsychotic medications.

Physical and developmental factors— impaired mobility (e.g. due to physical disability, advanced age or obesity) can affect an individual's capacity to adopt a healthy lifestyle and undertake physical activity. People with intellectual or developmental disability are at greater risk of obesity and obesity tends to occur at a younger age among people in this group. If there is no underlying syndrome to explain obesity, then dietary habits, physical inactivity and socioeconomic factors are thought to contribute to the risk (Melville *et al.* 2007) (31).

Socio-demographic factors

A range of social and demographic factors can affect the health behaviours of individuals:

Socioeconomic disadvantage— the relationship between socioeconomic disadvantage and increased risk of overweight and obesity is complex. Evidence from developed countries (including Australia) suggests a socioeconomic gradient in diet, with those in higher socioeconomic groups more likely to be able to afford nutritious foods (McLaren 2007) (32). Low household income is strongly associated with food insecurity, and there is evidence of a correlation between food insecurity and obesity, at least in women (Dinour *et al.* 2007) (33). Additional risk factors associated with poverty may include reduced access to services and limited opportunities for physical activity.

Rural and remote— the availability of better nutrition choices declines with remoteness (Queensland Health 2006) (34) and cost has been identified as a key factor in purchasing choices (NT DHCS 2007) (35). In addition, there is a lack of variety in sporting and community clubs, sports facilities (e.g. heated pools, commercial gymnasiums) and elements of the built environment that support physical activity, such as walking paths (NRHA 2011a) (36).

People from culturally and linguistically diverse backgrounds— in general, many migrants are as healthy or healthier than the Australian-born population, due to selective immigration policies. This effect often diminishes over time, and in some groups, the prevalence of overweight and obesity is greater than among the Australian-born population (AIHW 2010a) (37). Other groups, such as some refugees, may have complex health needs from arrival, and often have little or no family support. Nutritional deficiencies are common, along with mental health issues (e.g. anxiety, depression and post-traumatic stress disorder) (Vic DHS 2005) (38). Other factors contributing to the development of overweight and obesity among people from culturally and linguistically diverse backgrounds include (Renzaho 2004) (39) dietary acculturation, cultural beliefs and knowledge of food exposure to advertising and the media confusion over dietary guidelines, cost of food preferences and lifestyle.

LIFE STAGES:

Prenatal— there is evidence to suggest that in utero development has permanent effects on later growth and energy regulation.

Early childhood (0–4 years)— early childhood is also increasingly considered to be a critical period for programming long-term energy regulation, with clear evidence about the role of the early life environment in the later risk of obesity (Dietz 1997; Reilly *et al.*

2005)40. The early years are vital for establishing patterns of healthy nutrition and physical activity. Young childrens may be at greater risk of developing overweight and obesity due to parental modelling of behaviours that predispose children to weight gain.

Adiposity rebound (5–7 years)- at this age, BMI begins to increase rapidly, and food and activity patterns change as a result of exposure to other children and school. Early and rapid weight rebound often precedes obesity development.

Adolescence— adolescence is a period of increased autonomy that is often associated with irregular meals, changed food habits (e.g. through a desire for social acceptance) and periods of inactivity during leisure. These factors are combined with physiological changes that promote increased fat deposition, particularly in girls. Perceptions of body image can have a profound effect on dietary habits- for example, blaming food for changes to appearance or body shape can lead to disordered eating patterns. Adolescent girls who report dieting and extreme weight-control techniques are at increased risk of obesity (Stice *et al.* 2005)41.

Early adulthood- early adulthood usually correlates to a period of marked reduction in physical activity, and changes in diet and alcohol consumption. In women, this usually occurs between the ages of 15 and 19 years, but in men, it may be as late as the early 30s.

Women planning pregnancy- women with obesity are at greater risk of infertility compared with women in the healthy weight range, through direct effects on ovarian function and increased risk of polycystic ovary syndrome (Brewer & Balen 2010; Pasquali *et al.* 2007)42.

Pregnancy- women with overweight or obesity during pregnancy are at increased risk of pregnancy complications and of developing insulin resistance and gestational diabetes. Excessive weight gain during pregnancy often results in retention of weight after delivery, particularly with early cessation of breastfeeding. This pattern is often repeated after each pregnancy. Weight management for women who have a pre pregnancy BMI in the overweight or obese category has short- and long-term health benefits for the mother and baby.

Menopause- in Western societies, weight generally increases with age, but it is not certain why menopausal women are particularly prone to rapid weight gain. The cessation of menstruation is associated with an increase in food intake and a slight reduction in spontaneous activity.

Older people- the link between obesity and all-cause mortality lessens with increasing age and is greatly reduced or absent by the time people reach their early 80s (McTigue *et al.* 2006)⁴³. An association between obesity and reduced mortality has been found in older adults with heart failure (Curtis *et al.* 2005) ⁽⁴⁴⁾, following percutaneous coronary intervention (Lancefield *et al.* 2010)⁴⁵ and having dialysis (Kalantar-Zadeh *et al.* 2005)⁴⁶. However, quality of life is also an important consideration. Many older people already have limited mobility and obesity is likely to aggravate the problem and increase the risk of further functional limitation (Bennett *et al.* 2004)⁴⁷. Reduced mobility can affect people's social lives, increase dependence on others and affect mental health (Bennett *et al.* 2004)⁴⁸. The effect of excess weight on comorbidities such as type 2 diabetes can also reduce the ability of older people to participate in social and physical activities (McLaughlin *et al.* 2011)⁴⁹.

Self and body esteem

The association between overweight and global self-esteem in youngsters is not straightforward. Thus, some studies have indicated that overweight youngsters have lower self-esteem than non-obese teens (50,51,52,53,54,55,56,57) whereas other studies have shown no difference in the self-esteem of overweight and normal weight youngsters (58,59,60). Still, other studies have found that self-esteem is no longer lower in overweight children when controlling for the influence of body image and body dissatisfaction (61).

Self-esteem in overweight children and adolescents varies with gender, with females; may be at a greater risk of developing low self-esteem than males (62,63). The influence of age on self-esteem is not clear cut. Thus, some studies have shown that young overweight children are at particular risk for lower self-esteem (64), whereas in others, adolescents are more vulnerable than younger children (61,62).

The association between the severity of overweight and self-esteem in overweight and obese children is not straightforward. Still, although some studies have shown no association in obese youngsters between BMI levels and self-esteem (62) and others have suggested that many obese youngsters assessed in the community are not concerned with their weight 65 most studies do show a greater concern with weight in obese vs. normal weight children and adolescents, likely influencing their sense of self-esteem (66 -68).

The sociocultural status and region of residence may also have an influence on self-esteem. For example, overweight may influence self-esteem in Caucasian and Latin American but not

in African-American girls) (69,70), or in Australian as opposed to Hong Kong youngsters 60. In addition, low self-esteem in overweight youngsters may be related to the presence of disturbed eating (71), dieting behavior, and preoccupation with weight and shape (52,61,70) and to an overall inactive lifestyle 52, particularly among overweight females, these being in some cases even more influential than the actual overweight. Lastly, bullying has been found a worldwide factor in decreasing the sense of self-esteem of obese youngsters, irrespective of their age and gender 71.

The findings concerning the association of body image with overweight are more consistent in comparison to self-esteem. Favorable body image and perception have been found to be inversely correlated with the actual weight, and overweight youngsters usually show more body image disturbances and more body-related negative attitudes than their normal weight counterparts (58,69,56,60,72,73,74). In some studies (51,56,61) body dissatisfaction has been found to mediate the association between obesity and self-esteem, with obese children with greater body dissatisfaction having significantly lower self-esteem. Still, other studies have shown no mediating effect of body image on self-esteem (60).

Perceptions of Adolescent obesity



Considering the issue of popularity, overweight preadolescent girls are significantly less likely to be considered pretty, although they may not differ in popularity (75). A considerable decrease in popularity occurs during adolescence, as weight teasing in these age groups is highly correlated with actual weight. Weight-related teasing is greater in girls than in boys and in adolescents than in younger children (76). Moreover, overweight girls may report more victimization compared with their average-weight peers and are less likely to date than their peers (77,78). Similarly, overweight children and adolescents are often less liked, and less chosen as friends, and are more rejected, isolated and peripheral to social networks than their normal-weight peers (77,79). Indeed, large scale community-based studies have shown a greater prevalence of overweight and obesity in preschool children showing problematic relations with their peers in comparison to children with adaptive peer relationships (80).

There is currently growing literature showing that overweight and obese children and adolescents are targets of societal stigmatization and teasing by peers, educators, and even parents (77,81,82,83,75,76,84,85,86). Puhl and Latner (77) have recently critically analyzed the findings of the association between obesity, teasing, and health among youth. According

to these authors and others 86, higher BMI is associated with more frequent and intense stigmatization in children and adolescents of both sexes. Internalization of this weight stigma in overweight and obese youth has been found to be associated with lower self-esteem, decreased physical activity, and elevated depression, anxiety, suicidality, and body dissatisfaction.

Eating disorders

The lifetime rates of eating disorders (EDs), mainly bulimia nervosa (BN), binge eating disorder (BED) and/or ED not otherwise specified (ED-NOS), is significantly greater in clinical samples of overweight youngsters compared with population-based overweight groups (87,88,89). Moreover, clinically-referred obese patients with childhood-onset obesity have a significantly higher lifetime prevalence of EDs in general, and BN in particular, than adult-onset obesity patients 90. Still, although psychological traits associated with disordered eating, for example, pursuit of thinness and body dissatisfaction, appear among community samples of obese patients, being close in this respect to young ED patients, these obese youngsters do not usually show clinically full-blown ED

Furthermore, if an overweight youngster has an ED, its course and outcome are less favorable if the ED develops in the context of premorbid normal weight, in comparison to premorbid overweight 90.

Although obesity per se is not classified as an ED, it shares important psychosocial antecedents of EDs. Accordingly, peer teasing, disturbed self- and body-esteem, and self-directed and naturalistic dieting may be all precursors for the development of both disturbances (91). Furthermore, elevated weight may increase the risk for the development of an ED 85, conversely, disturbed eating, in children in particular binge eating, may predict an increase in body fat (91). It is, thus, not surprising that prevention programs targeted for both problems are similar in many cardinal aspects 85, and programs aimed toward reducing the risk of one may often improve also the condition of the other 86.

Binge eating disorder (BED)

BED is defined as a subcategory of the ED-NOS diagnosis in which uncontrolled binge eating episodes occur at least twice a week for a period of no less than three consecutive months, with no evidence of weight-reduction compensatory behaviors [63]. Two patterns of

BED have been identified in both adults and adolescents, in that the onset of binge eating may occur either before or after the onset of dieting. Whereas in the dieting-associated BED subtype, binge eating usually appears in late adolescence, non-dieting BED may appear as early as 11–13 years of age 92,93,94,95.

BED is currently considered a major clinical problem in overweight individuals 73,96, as 20–40% of severely obese adults 92,97 and adolescents 73, 98,99,100, 101, 102 seeking treatment report significant binge eating symptomatology. The prevalence of BED and subthreshold BED among adult overweight individuals in the general community is much lower (5-8%).103, 104 Although the findings for children and adolescents are still inconclusive 92, some studies have shown that up to 5.3% of overweight children 6–10 years of age may be diagnosed with BED 105.

Studies that have associated binge eating only with eating a large amount of food have shown that boys report more binges and recurrent bingeing behaviors, but girls are more embarrassed and self-critical about their binges 106. By contrast, studies that define binge eating as including loss of control over eating as well, have found a greater extent of bingeing behaviors among girls, in keeping with findings in adults 107,108,109,110,111. With respect to age, binge eating has been found to increase with age for Caucasian youngsters and decrease with age for African-American youngsters, independent of gender 112. Compensatory weight reduction purging and non-purging restricting behaviors occur only infrequently in overweight youngsters.

For both children and adolescents, a personal and family history of obesity likely increases the risk for the development of binge eating in the context of adverse childhood experiences, problematic family relationships, maladaptive parental eating-related attitudes, weak social support and elevated psychiatric morbidity (particularly depression, but also emotional disinhibition) 113,114. It is not yet clear whether binge eating or BED in childhood and adolescence continuous to BED in adulthood 92.

The implications of binge-eating behavior have been repeatedly investigated in overweight adults, but only a few studies have evaluated this behavior in overweight children and adolescents. The presence of binge eating behavior in overweight individuals signifies the likelihood of greater eating-related and non-eating related lifetime morbidity in comparison to non-binge eating overweight, although an inclination towards more severe overweight has

been found only in adult 115 but not in adolescent binge eaters. Non-bingeing severely overweight adults 58 and adolescents 73 reports relatively few psychological difficulties, although they do score low on self-esteem, and may show considerable social difficulties. By contrast, overweight children and adolescents with binge eating behavior and BED, characterized by loss of control over eating above and beyond overeating, show problematic eating behaviors, particularly eating in the absence of hunger and in secrecy 67,114,116. These youngsters eat significantly more, have greater weight and shape concerns, as well as significantly elevated levels of depressive and anxiety symptoms and significantly lower self-esteem, in comparison to non-bingeing overweight youngsters 67, 73,105, 117. In addition, the greater the severity of bingeing behavior among overweight youngsters, the more are these youngsters at risk to develop depression, anxiety, and self-and body esteem problems 73,117.

Both adult and adolescent overweight binge eaters do not usually compensate for bingeing episodes by restricting food intake between episodes 118, and loss of control over eating in childhood binge eating is usually not associated with dieting 105. Dieting behavior is usually not a necessary factor for the development of binge eating in overweight children 92, whereas adult overweight binge-eating individuals do diet more frequently than overweight non-binge eaters. From a different perspective, studies in adults have shown that BED and BN represent different syndromes on a continuum of disturbed eating that are likely associated with different etiological factors 92. Accordingly, patients with BN show greater eating related and non-eating related psychopathology than BED patients 119. This phenomenon has not been investigated yet in adolescents, but apparently, BED in youngsters does not develop into BN in later life 92.

Binge eating behavior can be identified early in childhood 105,109, is relatively frequent among young overweight individuals, and can lead to considerable emotional distress and psychiatric morbidity 67, 92, 117. Nevertheless, although binge eating is defined identically in children, adolescents and adults, converging evidence indicates that it is difficult to systematically diagnose BED in young children with accepted adult criteria 120. Factors considered of particular relevance for this diagnostic ambiguity are the inclination of children either not to understand the meaning of loss of control when it comes to binge-eating, or to frankly deny such behaviors when asked, out of shame and embarrassment 67, 96, 116. Moreover, parents also tend to deny binge-eating in their children for similar reasons. Large

scale community studies applying broad, less stringent and developmentally-appropriate criteria for the characterization of BED (for example, inclusion of food seeking in the absence of hunger, and sneaking or hiding food), using age appropriate interview techniques for both children and parents, are required to improve the characterization of BED in younger age groups

PARENTAL INFLUENCES AND ATTITUDES

The likelihood of the family to be involved in the predisposition to obesity in their children and in the well-being of their obese children may be associated with a host of familial variables. These include the knowledge and involvement of the parents in the selection of food, control over food and the patterns of eating at home (e.g., the provision of healthy food, the insistence on breakfast, and the family's meals patterns), the acting of the parents as role models and their overall impact on healthy eating and physical activity, and issues related to family dieting, satisfaction with one's body and weight teasing at home 121,122,123.

Another important factor in the well-being of obese children relates to the influence of parental psychopathology and distress on the emotional condition of the overweight child. For example, maternal anxiety may predict the overweight child's severity of depression and anxiety (134). Still, the presence of adequate coping strategies in the child may considerably reduce the impact of the mother's mental state on his/her well-being 124. In addition, child neglect has been found a specifically important factor in the predisposition to obesity at young ages 125.

Thirdly, several parenting styles have been found more prevalent than others in families of obese children in comparison to normal weight children 123. Parenting style is defined as the combination of attitudes and the emotional climate created by parents through which parental behaviors or practices are expressed. The parenting style defined as authoritarian seems to be specifically prevalent in families of obese children 123. This style is high in parental demanding and control and low in responsiveness, i.e. low in fostering individuality and self-assertion. As such, it may interfere with teaching the child how to choose the appropriate food and regulate food choice. In addition, parenting styles defined by low demanding and high responsiveness (permissive) and by low demanding and low responsiveness (neglectful) increase the odds of having an overweight child 126. By contrast, the authoritative parenting style, which is high in both demanding and responsiveness, sets the structure for adequate

food choice at home and supports the child in learning how to handle effectively issues related to food choice both at home and outside of home. As such, it has been found prevalent in families of normal weight children and infrequent in obese children.

ATTITUDES OF PARENTS TOWARD THEIR CHILD'S OVERWEIGHT

Parents of overweight/obese children may be either not worried 127 -133 about their child's weight, or, alternatively, be over-concerned with and critical about it 133,134. Not surprisingly, ignoring weight may be considerable in parents of overweight children (above 80%), than in parents of obese children (less but not 20%) 135. Furthermore, parents are more concerned about their young children being underweight than overweight 136. Accordingly, one study has shown that more than 50% of mothers perceiving their child to be overweight or obese are not concerned about it 129.

One explanation for the inconsistencies in parental perceptions of their child's overweight likely relates to the tendency of parents to be unaware 128, misperceive 137, 138 or disconnect between the perceived and actual weight of their child 135,139. For example, over 70% of mothers of overweight children see them as being of similar weight to their peers, as being equally as or more active than other children, and as having a diet at least as healthy as their peers 140. Parents mostly underestimate their child's weight, with more than 50% of parents of obese and overweight children being unable to recognize when their child is overweight 128,135,142, 143, 144, 145. Still, in some studies, parents have been found to overestimate their overweight child's weight. 138

The inclination for misperception is greater for boys than for girls 138. In addition, parents of young overweight children misperceive their child's weight to a greater extent than parents of overweight adolescents (65% vs. 51% respectively, 136. Interestingly, parents tend to perceive their child's weight significantly less accurately than their own 129,146. There is some debate whether the inaccuracy in the perception of the child's weight is related to parental overweight. Whereas some studies have found no association between parental perceptual inaccuracy and parental overweight 136, others have shown a significant difference in the proportion of distorted perception of shape between mothers of normal-weight children vs. those of overweight and obese children (17 vs. 87.5%, respectively, 153). This inaccuracy in perception is not related to socio-economic status and education level in some studies 145, 152, whereas others 139 have shown greater misperception in families with

lower education levels. In addition, African-American parents have been found twice as likely to underestimate as Caucasians 145. BMI screening and feedback may improve parental perception to some extent 145.

In addition to parental misperception about overweight, mothers may exhibit poor overall ability to estimate the way their overweight and obese children eat 137, 139. A significant difference may thus, be found in the proportion of distorted perception of eating habits between mothers of normal-weight children vs. those of overweight and obese children (36.3 vs. 90.8%, see 153). Eighty-four and 96% of mothers of obese and overweight children, respectively, in that study, have actually thought that their children ate right or little 153. Most importantly, mothers distorted perceptions of shape and eating habits of their overweight children 153, found already during infancy 147, may become significant independent risk factors for the prediction of frank obesity in later life.

Parental attitudes toward obesity in their children may be associated with the child's gender and age, as well as with their own ethnic background and level of education. For example, parents of boys 150, or of African-American descent, or with less education 148, have been shown to associate lower risk to their child's overweight. Parents with less education are also less inclined to take action to prevent unhealthy weight gain in their children 138. Parents of overweight children tend not to include weight in their distinction of health and have been found to be more concerned with their child's health than with his/her weight 149.

Unfortunately, not only parental lack of concern 153, but also their over concern 144, may be associated with elevated BMI and adiposity in their children. Factors increasing parental weight concern include higher child BMI, less parental underestimation of child body size and lower child health-related quality of life 141. In other studies, parents have been found to be concerned about overweight among children and adolescents in general, but are reluctant to address it with their own children 150. Conversely, some researchers have reported no difference in the manner in which parents of normal and overweight children estimate their weight, with both groups likely inclining toward underestimation 151.

One of the most important factors affecting parental attitude toward their child's overweight is the manner in which parents perceive and are preoccupied with their own weight. Accordingly, parents are more likely to worry about their child's potential for future overweight if they or the other parent are, or have been overweight 137. In addition, parents

may become over-concerned with their child's overweight as the result of problematic consultations they have had with health care professionals 152. Lastly, although parents appreciate the role of diet and inactivity in the causation of overweight, they tend to underestimate the difficulties involved in their children's attempts to change maladaptive eating behaviors .153, 154

Parents may endorse and transmit weight based stereotypes to their children. Moreover, children's perceptions about their own overweight have been found to be influenced to a greater extent by the manner in which their parents relate to their overweight than by their actual BMI. For example, for overweight girls, their mothers weight-related over-reacting, likely leading to restriction of food, and their fathers overt criticism about their weight, are among the factors that have the most detrimental influence on their self-perception 155, 156 and well-being 157. By contrast, lack of parental criticism with respect to the child's overweight may be a protective factor for the child's self-esteem 158. The latter youngsters tend to use adaptive compensatory methods for the regulation of self-esteem, such as reducing the importance of areas in which they are less competent and increasing the importance of domains in which they perform well 159, 160

CO-MORBIDITIES RELATED TO OBESITY

METABOLIC SYNDROME

Metabolic syndrome is defined as a constellation of risk factors, including obesity, dyslipidaemia, impaired glucose metabolism and elevated blood pressure, all major predictors for cardiovascular disease.¹⁶¹ It has been proven by previous studies that cardio metabolic risk factors frequently cluster in obese children and adolescents. Goodman *et al* ¹⁶² identified four clusters of risk factors in adolescents and found that obesity had the most substantial influence on cumulative cardio metabolic risk. Each component of the syndrome worsens with increasing obesity independent of age, sex, and pubertal status.¹⁶³

The trigger factor for initiation of events leading to metabolic syndrome in obesity is not clearly identified. Two schools of thought predominate, one focusing on intra-abdominal fat depots and the other on insulin resistance as starting points. Accumulation of visceral fat is characterized by high lipid turnover resulting in higher levels of free fatty acids (FFA) in the portal circulation.¹⁶⁴ This could lead to enhanced lipid synthesis, gluconeogenesis, insulin resistance and activation of sympathetic nervous system 165-167. Activation of sympathetic

nervous system can contribute to elevation of blood pressure through its effects on vascular tissue as well as renal handling of sodium and water 168,169. Insulin resistance can independently lead to increased hepatic synthesis of very low-density lipoprotein (VLDL), resistance of the action of insulin on lipoprotein lipase in peripheral tissues, enhanced cholesterol synthesis, increased high-density lipoprotein (HDL) degradation, increased sympathetic activity, proliferation of vascular smooth muscle cells, and increased formation and decreased reduction of plaque 170. The prevalence of metabolic syndrome in obese children and adolescents vary with the type of diagnostic definition used as well as the population studied. Evidence from large international studies suggests that it could range from 10 to 40 per cent depending on the levels of obesity 171. Similar trends were reported from adolescent Indian population as well 172.

TYPE 2 DIABETES MELLITUS

The association of obesity with type 2 diabetes in adolescents and children is very strong and confirmed by various studies. Evidence entail that obesity driven type 2 diabetes might become the most common form of newly diagnosed diabetes in adolescent youth within 10 years 173. Evidence is accumulating which suggests a global spread of type 2 diabetes in childhood 174. Traditionally type 2 diabetes mellitus had been a disease of adults; however, the same now occurs in increased numbers among obese adolescents 170. Studies demonstrate an increased risk of nephropathy and retinopathy compared to young people with type 1 diabetes, while recent data indicate early signs of cardiovascular disease in youth with type 2 diabetes 175,176,177 Evidence is emerging of a growing prevalence of type 2 diabetes among urban Indian children as well 178

CARDIOVASCULAR ABNORMALITIES

Obesity significantly contributes to morbidity and mortality from cardiovascular disease. Obesity may affect the heart through its influence on known risk factors such as dyslipidaemia, hypertension, glucose intolerance, inflammatory markers, obstructive sleep apnoea/hypoventilation, and the prothrombotic state, as well as through yet unrecognized mechanisms. Landmark studies like Bogalusa, Muscatine and Cardiovascular risk in young have demonstrated that obesity during childhood and adolescence is a determinant of a number of cardiovascular risk factors in adulthood 179,180,181. Studies have demonstrated a significant association of obesity with hypertension in children and adolescents 182. These

studies have shown that the association is stronger in case of systolic hypertension than that of diastolic hypertension. Left ventricular hypertrophy, a well-known cardiovascular risk factor has an association with obesity even from childhood which tracks and becomes stronger in young adulthood 183. Emerging cardiovascular risk factors like carotid intima media thickness as well as carotid elasticity have also shown strong association with childhood obesity 181. Obstructive sleep apnoea, a well-known cardiovascular risk factor is also associated with obesity in children and has also shown to induce insulin resistance. Treatment of this condition improves lipid profiles, C-reactive protein, and apolipoprotein B which confirms its pathogenic role in lipid homeostasis and systemic inflammation 184.

PSYCHOSOCIAL ABNORMALITIES

Psychosocial abnormalities are closely associated with obesity in children and adolescents. Obesity in adolescence may be associated with later depression in adulthood 185. In addition, abdominal obesity seems to be strongly associated with concomitant depression in males. Though both sexes can be affected by obesity-induced depression, females demonstrate a more robust association. Females obese as adolescents may be at increased risk for development of depression or anxiety disorders 186. Among obese children, appearance related teasing is more frequent and upsetting. Degree of teasing is associated with higher weight concerns, more loneliness, poor self-perception of physical appearance, higher preference for sedentary or isolated activities and lower preference for social activities 187. Overeating among adolescents is associated with a variety of adverse behaviours and negative psychological experiences including low self-esteem and suicidal tendencies 18. The association of suicidal tendencies is stronger in those meeting the criteria for binge eating syndrome.

TREATMENT OF OBESITY:

The treatment of overweight and obesity in children and adolescents requires a multidisciplinary approach with a holistic outlook. The team should include a pediatric physician, nurse practitioner, dietician, physical instructor, behavioural therapist and a social worker in addition to a motivated team of parents, caretakers, teachers and policy makers. The immediate goal is to bring down the rate of weight gain, followed by a period of weight maintenance and finally weight reduction to improve BMI. The long-term goal is to improve

quality of life and reduction in morbidity as well as mortality associated with overweight and obesity.

TARGETS FOR OBESITY TREATMENT

No targets are defined for treating children less than two years who have overweight or obesity. For overweight children in the age group of 2-5 yrs weight maintenance is all that is required. For obese children in the same group, weight maintenance is attempted. A minimal weight loss of 0.5 kg/month may be permitted if it occurs with a balanced diet supplying adequate calories¹⁸⁹. For overweight children in the age group of 6-11 yrs weight maintenance is adequate. For obese children in the same group, weight maintenance or a minimal weight loss of 0.5 kg/month may be attempted. If the child's BMI is more than 99th percentile, a moderate weight loss of not more than 1 kg/wk may be attempted. For overweight adolescents in the age group of 12-18 yrs weight maintenance is adequate. For obese adolescents in the same group, a moderate weight loss not more than 1 kg/wk may be attempted¹⁸⁹.

COMPONENTS AND PHASES OF OBESITY TREATMENT



The components of overweight and obesity treatment include dietary management, physical activity enhancement and restriction of sedentary behaviour, pharmacotherapy and bariatric surgery. The various phases of obesity management in ascending order of intensity include prevention oriented approach, structured weight management, comprehensive multidisciplinary intervention and tertiary care intervention. Each component goes through the various phases as required.

DIETARY MANAGEMENT

Dietary management should aim at weight maintenance or weight loss without compromising appropriate calorie intake and normal nutrition. Due emphasis should be given to initiate and maintain healthy eating patterns. A standard protocol is to recommend a fat intake of 30 to 40 per cent kcal in children 1 to 3 yr old, with a reduction to 25 to 35 per cent in children 4 to 18 yr old; a carbohydrate intake of 45 to 65 per cent kcal in all children and adults; and protein intakes of 5 to 20 per cent kcal in children 1 to 3 yr old with gradual increase to 10 to 30 per cent kcal in children 4 to 18 yr old¹⁹⁰

In obese children 8 yr or older, the Dietary Intervention Study in Children (DISC) intervention diet can be introduced without compromising growth, development and pubertal maturity¹⁹¹. This diet distributes 58 per cent of total calorie intake to carbohydrates, 28 per cent to fats and 14 per cent to protein. Of the 28 per cent calories from fats, 11 per cent should be from monounsaturates, 9 per cent from polyunsaturates and less than 8 per cent from saturates. Cholesterol intake should be less than 75 mg/1000 kilocalories, not to exceed 150 mg per day. Age-appropriate serving sizes including 5 or more servings of fruit and vegetables, 3 or more servings of low fat milk or dairy products, and 6 or more servings of whole-grain and grain products per day as well as adequate amounts of dietary fiber (age in yr + 5 g/d) should also be encouraged¹⁷⁰.

Due emphasis should be given to reduction of eat outs, planning for healthy snacks, balanced diet, adequate intake of fruits and vegetables, fiber content of diet and avoidance of high calorie/high fat foods. The benefits of salt reduction, restriction of sugar rich beverages and avoidance of trans fatty acids from the diet are supported with strong evidence^{192,193,194}

PHYSICAL ACTIVITY ENHANCEMENT

Moderate intensity of regular physical activity is essential for the prevention of overweight and obesity as well as for treatment of the same. Children and adolescents should engage in not less than 60 min of moderate to vigorous physical activity per day to achieve optimum cardiovascular health¹⁹⁵. Overweight and obese children should target higher levels to achieve similar results. Longer periods of moderate intensity exercises like brisk walking burn more fat as calories and are excellent for reducing body fat¹⁹⁶. Children should be prescribed physical activity that is safe, developmentally appropriate, interesting, practical and has a social element. Involving other members of the family in the exercise programme and supervising the activity on a regular basis will improve compliance. In addition to weight reduction, exercise training is associated with beneficial changes in fat and lean body mass, cardiovascular fitness, muscular strength, endothelial function and glucose metabolism, all of which significantly reduce the morbidity associated with excess weight¹⁹⁷.

RESTRICTION OF SEDENTARY BEHAVIOR

Children and adolescents typically indulge in sedentary activity like watching TV, sitting in front of computers and video games. Every hour of sedentary activity increases the chance of obesity and is also contributory to failure of many weight reduction attempts in adolescents

and children. Screen time should be restricted to less than two hours per day as the opposite is associated with increased adiposity and higher weight status 198. In addition, television viewing during early childhood predicts adult body mass index, which reinforces the long-term benefits of reducing screen time in young age 199. Excessive TV viewing is associated with higher intakes of energy, fat, sweet and salty snacks and carbonated beverages in addition to reducing consumption of fruits and vegetables 200. This makes TV time restriction an excellent opportunity to complement dietary management.

PHARMACOLOGICAL TREATMENT

Data supporting the use of pharmacological therapy for pediatric obesity are limited. The drugs sibutramine, orlistat and metformin are currently in use among obese children and adolescents with varying results. Sibutramine, a serotonin noradrenaline reuptake inhibitor enhances satiety and has been shown to be the most effective drug in treating adolescent obesity. This drug may be associated with side effects including increases in heart rate and blood pressure limiting its use in obese adolescents with higher blood pressure 201,202 Orlistat, which is a pancreatic lipase inhibitor, acts by increasing faecal fat loss. It is associated with flatulence, diarrhoea, gallbladder diseases, mal-absorptive stools and requires fat-soluble vitamin supplementation and monitoring 202,203 Orlistat appears to be less effective in those who follow diets which are low in fats as is the case of many Indian diets. Metformin is a valuable adjuvant to the treatment of obese adolescents with severe insulin resistance, impaired glucose tolerance or polycystic ovarian syndrome 201. Pharmacotherapy should be reserved as a second line of management and should be considered only when insulin resistance, impaired glucose tolerance, hepatic steatosis, dyslipidaemia or severe menstrual dysfunction persist in spite of lifestyle interventions.

SURGICAL TREATMENT

Many cases of severe adolescent obesity warrant aggressive approaches including surgical treatment. Adolescent candidates for bariatric surgery should be very severely obese (defined by body mass index of > 40), have attained a majority of skeletal maturity (generally > 13 yr of age for girls and > 15 yr of age for boys), and have co-morbidities related to obesity that might be remedied with durable weight loss 204. More severe elevation of BMI ($> 50 \text{ kg/m}^2$) may be an indication for surgical treatment in the presence of less severe co-morbidities. The bariatric procedures preferred in adolescents are Roux-en-Y gastric bypass and adjustable

gastric banding. Late complications include small-bowel obstruction, incisional hernias, weight regain, as well as vitamin and micronutrient deficiencies. These patients warrant meticulous, lifelong medical supervision. Current evidence suggests that after bariatric surgery, adolescents lose significant weight and comorbidities are appreciably reduced. Bariatric surgery performed in the adolescent period may be more effective treatment for childhood-onset extreme obesity than delaying surgery till adulthood 205.

PREVENTION OF OBESITY

The ideal preventive strategy for obesity is to prevent children with a normal, desirable BMI from becoming overweight or obese. Preventive strategies should start as early as newborn period. The strategies may be attempted at the individual, community or physician's level. Those at the individual level backed by consistent evidence include limiting sugar sweetened beverages, reducing daily screen time to less than two hours, removing television and computers from primary sleeping areas, eating breakfast regularly, limiting eating out especially at fast food outlets, encouraging family meals and limiting portion sizes 206. Encouraging diets with recommended quantities of fruits and vegetables have been supported by mixed evidence. Healthy behaviours derived from this evidence include consuming a balanced diet rich in calcium and fiber, initiating and maintaining breastfeeding, accumulating 60 min or more of moderate to vigorous physical activity per day and limiting consumption of energy dense foods.189

Community level interventions include advocacy to increase physical activity at schools and at home through the creation of environments that support physical activity. These efforts could include creation and maintenance of parks, inclusion of child friendly walking and bicycle paths as well as creating awareness about locally available physical activity options. At the physician's level, it is essential to engage families with parental obesity or diabetes because these children are at increased risk of developing obesity later in life 207. It is also essential to encourage an authoritarian parenting style and to discourage a restrictive one. Physicians should encourage parents to be role models when it comes to healthy diets, portion sizes, physical activity and screen time. Regular enquiries regarding diet and physical activity on routine visits will enhance awareness about the need for positive modifications.

FUTURE DIRECTIONS

A holistic approach to tackle the childhood obesity epidemic needs an array of activities which includes steps like influencing policy makers and legislation, mobilizing communities, restructuring organizational practices, establishing coalitions and networks, empowering providers, imparting community education as well as enriching and reinforcing individual knowledge and skills 208. Schools, child care facilities and primary health care centers are important settings for implementation of policies and programmes. Relevant attempts may involve specifying the nutrition composition of foods served in school canteens as well as other outlets, supporting requirements for physical education in schools, increasing the availability of physical activity options or the time available to utilize these options, implementing training programs to empower school teachers to provide nutrition or physical education, and providing financial as well as technical support for programmes and services related to weight control. The advantage of setting-based approaches of this type includes the ability to work with a “captive audience” and to also influence social norms within the setting, with possible transfer to behaviour outside of the setting. Of the possible setting-based interventions, there is sufficient evidence to recommend multi component interventions aimed at diet, physical activity, and cognitive change which makes the approach a holistic and efficient one with demonstrable results 209

CONCLUSION

Addressing childhood obesity requires a comprehensive holistic approach. Although the evidence is limited, increased physical activity alone has not improved children’s weight status substantially. Promotion of routine physical activity in children from preschool age on may help prevent the development of overweight and obesity and has other benefits, including reductions in cardiovascular disease risk factors. Particular consideration should be given to methods of increasing activity in adolescents. Studies suggested that time, cost, availability, and convenience were key factors that influenced what adolescents ate and whether they were physically active. Students reported that social support from friends and family members, as well as teachers and adults who modeled healthy behaviors, enhanced their likelihood of eating healthy foods and being physically active. Finally, the American Academy of Pediatrics recommends that all children meet the goal of 60 minutes of moderate activity per day; schools be provided with the necessary resources to incorporate 30 minutes of moderate to intense activity into each student’s daily schedule; clinicians instruct

parents on techniques for increasing activity in the home environment, including reducing time spent in sedentary activities; and health care providers become involved in the community to address access and safety issues. This is a multifaceted problem, related to greater school absenteeism and overall psychosocial stress, less nutritious diet and physical activity, more behavioral problems, and less favorable neuropsychological functioning. The use of weight loss medications in obesity treatment has a complicated history. Many medications used to treat obesity were eventually withdrawn from the market or their use restricted after documentation of dangerous side effects.

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