HK J Paediatr (new series) 2004;**9**:340-353

Ocassional Survey

Obesity: An Emerging Epidemic Problem

RWM ***Au,*** LCK ***Low***

Abstract According to the World Health Organization, obesity should be regarded as a disease rather than a lifestyle problem. The prevalence of obesity is on the increase in the adult and childhood population worldwide. Although genetic factors play a role in the individual predisposition to obesity, monogenic causes of severe obesity are rare. The lack of physical activity and sedentary lifestyle in the population are important contributing factors in the obesity epidemic worldwide. The body mass index (BMI) has been proposed as a good clinical measure for the definition of obesity in children and adolescents. Using an international BMI reference derived from 6 population studies, 10.3% and 6.3% of 15-year-old boys and girls in Hong Kong were found to be overweight or obese. Even in childhood and adolescents, obesity-related co-morbidities exist including the metabolic syndrome, hypertension, pulmonary complications and musculoskeletal problems. Childhood obesity can lead to significant psychosocial consequences including negative self-mage, low self esteem and poor quality of life. Psychosocial distress and psychiatric disorder in children and adolescents may be more associated with parental psychosocial and psychiatric problem than the child's own BMI, age or sex. Approximately 10-30% of obese persons who seek weight reduction suffer from binge eating. Unfortunately, there is currently limited high quality data on the effectiveness of obesity prevention programmes. Numerous long-term and short-term studies have been conducted to assess the effectiveness of educational, psychological and behavioural therapy, for the individual and family focussing on diet, physical activity, social support and lifestyle changes and the results have not been encouraging. Studies on the metabolic and psychological sequalae of childhood and adolescent obesity are needed in Hong Kong. Targeted screening for type 2 diabetes mellitus in obese children and adolescents is indicated.

Key words Metabolic syndrome; Obesity; Prevalence; Psychological sequalae

Factors Leading to Obesity

Obesity is a heterogeneous group of disorders resulting from energy imbalance over a period of time. Genetic, environment and psychosocial factors, which act through the physiological mediators of energy intake and expenditure, contribute to the maintenance of body weight.

Genetic factors play a role on individual predisposition and operate through susceptibility genes. Twin studies suggest that at least 50% of the tendency toward obesity is inherited.[1-3] Therefore, the differences in genetic susceptibility within a population determine those who are most likely to become obese in any given set of environmental circumstances. A series of studies involving monozygotic twin pairs have been performed which investigate the role of the genotype in determining the response to changes in energy balance. These twins were

Department of Paediatrics & Adolescent Medicine, Queen Mary Hospital, The University of Hong Kong, Pokfulam, Hong Kong, China

RWM **Au** （歐慧敏） *BSc*
LCK **Low** （盧忠啟） *FHKAM(Paed), FRCPCH*

Correspondence to: Prof. LCK **Low**

Received January 27, 2004

submitted either to positive energy balance induced by long-term overfeeding[4] or to negative energy balance induced by exercise training in the presence of constant energy intake conditions.[5] The long-term overfeeding study recruited 12 pairs of healthy male monozygotic twins with no familial history of obesity, hyperlipidaemia, or diabetes. They were given a 4.2MJ (1000 kcal) energy surplus consumed over 6 days/week for 100 consecutive days. Significant increase in body weight and fat mass were observed after the overfeeding period. The data also indicated that there were considerable inter-individual differences in the adaptation to excess energy. There was 6 times more variance of abdominal visceral fat distribution between pairs than within pairs. This suggested that, in response to an energy surplus, some individuals store fat predominantly in selected fat depots primarily as a result of undetermined genetic characteristics.[6] In the negative energy balance study, seven pairs of male identical twins were to exercise on bicycle ergometers twice a day for 9 out of 10 days over a period of 93 days while maintaining constant daily energy intake. Monozygotic twins had a similar response to negative energy balance while dizygotic twins showed a much greater variation in response to negative energy balance, particularly for changes in subcutaneous fat, fat mass and visceral fat. The findings suggested that there are considerable differences in the way individuals respond to chronic alterations in energy balance conditions.[6] The genotype, therefore, plays a significant role in determining the biological variability in the responsiveness to energy deprivation and energy excess.

At least five monogenic forms of obesity in humans have been revealed by recent molecular genetic studies. They include leptin,[7,8] leptin receptor,[9] prohormone convertase 1 (PC1),[10] proopiomelanocortin (POMC),[11] and melanocortin-4 receptor (MC4R).[12-15] Leptin, the adipocyte product, was discovered to feed back the signal of body fatness to the hypothalamus and regulates food intake in rodents. The fact that leptin serum levels are positively correlated with the percentage body fat and are high in obese humans, has led to the hypothesis that leptin insensitivity contributes to the further progressive development of obesity in overweight humans.[16] When leptin was administered to children with leptin deficiency, it led to striking decrease of food intake, suppression of appetite, continuous weight loss and restoration of endocrine disturbances.[17-19] The main effect of leptin in inducing weight loss was mediated by its suppressive effect on food intake. These findings raised important questions about the primary role of leptin in humans and demonstrated the complexity of human hypothalamic function compared to rodent.[20] POMC is produced by hypothalamic neurons of the arcuate nucleus and is sequentially cleaved by prohormone convertases to yield peptides (including α melanocyte stimulating hormone, αMSH) that have been shown to play a role in feeding behaviour.[21] In rodent, it has been demonstrated that αMSH acts as a suppressor of feeding behaviour. MC4R, one form of melanocortin receptors, is highly expressed in areas of the hypothalamus involved in feeding behaviour. Mice with MC4R disrupted by gene targeting become severely obese, hyperinsulinaemic, and exhibiting increased linear growth.[22] MC4R mutation has become the commonest known monogenic cause of human obesity in which individual with this mutation were found to have severe early onset of obesity, tall stature,[13] but no defect in resting energy expenditure.[12]

Environmental factors, which are thought to be one of the contributors to obesity, include diet modification and lifestyle alteration. With the increasing 'westernisation' of eating habits, e.g. increase in the consumption of high fat and energy dense foods and decrease in fiber intake, the prevalence of obesity is on a rising trend. Consuming a diet high in fruit, vegetables, low-fat dairy product, and whole grains and low in red and processed meat, fast food, and soda was associated with smaller gains in body mass index (BMI) and waist circumference.[23,24] Lack of physical activity and sedentary behaviour in recent years have also led to the dramatic increase in incidence of obesity worldwide. Television Viewing (TV) appears to promote obesity by displacing physical activity, which reduces energy expenditure, and increasing dietary energy intake from eating during viewing or from the effects of food advertising.[25] Television advertising and programming tend to emphasise high-caloic foods of poor nutritional quality, rather than nutritionally rich foods such as fruits and vegetables.[26] Exposure to food advertisements may produce incorrect nutritional beliefs among children.[27,28] A strong dose-response relationship between the prevalence of overweight and hours of television was observed in a study conducted in 1990 which involved 746 youths aged 10 to 15 years.[29] Children and adolescents in the United States who watched the most number of hours of television a day (>5 hours/day) had the highest prevalence of obesity.[30] Food meals high in fat and TV viewing hours were positively associated with energy intake and body mass index in women living in the United States.[26]

Obesity in Adults

Obesity is defined medically as a disease of excessive accumulation of body fat in the body, associated with an increase in body weight beyond the limitation of skeletal and physical requirement, such that health and well-being of an individual are adversely affected. In the past, obesity has been surprisingly ignored as a public health problem by many nations partly due to the fact that this medical condition is seldom classified as a disease. The World Health Organization (WHO) commented that obesity should be recognised as a disease in its own right. It is now agreed that "obesity's impact is so diverse and extreme that it should now be regarded as one of the greatest neglected public health problems of our time with an impact on health which may well prove to be as great as that of smoking".[31] Like many other countries, childhood obesity has not been regarded as a significant medical problem in Hong Kong until recently.

Western Countries

In 1995, it is estimated that there are 200 million obese adults worldwide.[31] Currently, it is estimated that the global number of individuals affected by obesity exceeds 250 million, or 7% of the world's adult population.[32] The prevalence of obesity in the general population of both Australia and New Zealand has shown to be in the range of 10-15%.[33] Obesity rose 6 percent nationally between 1998 and 1999, and the increase affected all regions and demographic groups and most states in the United States.[34] Approximately, 20% of the American males and 25% of the American females are currently obese, with body mass index (BMI) ≥30 kgm^{-2}.[35] The projected prevalence (BMI ≥30 kgm^{-2}) in the adult population of the United States will be 30% for the year 2015 and over 40% for the year 2025.[20]

Secular trends in the prevalence of overweight and obesity have been observed in many European countries. More than half of the adult population between 35 and 65 years of age in Europe are either overweight or obese. Over the last 10 years, the prevalence of obesity in the majority of European countries has increased by approximately 10 -40%. On average, 15% of the European men and 22% of the European women are obese, with overweight being more common among women than men.[20] In England and Wales, an increase in the prevalence of obesity in adults from 6% in men and 8% in women in 1980 to 17% of men and 20% of women in 1997 has been reported.[36]

Asian Countries

The occurrence of obesity is not confined merely to the Western countries and obesity is also prevalent in many Asian populations. The prevalence of adult obesity for Asia was estimated as a whole to be 2.9%, with a higher prevalence of 4.3% in Eastern Asia and 2.4% in Southeast Asia.[35] In the past, research and nutritional policy have emphasised on the problems associated with undernutrition. Most of the Asian countries such as Japan, India, Singapore, Malaysia, and China are now beginning to experience high levels of overweight and obesity.[37]

The National Nutrition Survey in Japan (NNS-J) in 2000 reported that 24.5% of men and 17.8% of women were overweight while 2.3% of men and 3.4% of women were obese. The prevalence of overweight and obesity among male Japanese appears to be increasing. However over the same period of time, the overall prevalence of overweight among women has remain unchanged.[38,39] Although the fraction of the population of obese adults is quite low compared with western societies and some other Asian countries, the prevalence of overweight and obese has already reached one-fifth or one-fourth of Japanese adults.[39,40]

It is also important to note that obesity is not limited to industrialised countries as obese population can be seen in developing countries. In urban India, the number of overweight adults is increasing and is becoming a serious problem, especially among the upper-class population. Similarly, obesity rate in Thailand, at least in wealthy urban population, is increasing. In 1991, 3% of men and 3.8% of women were classified as obese in a small study of 66 men and 453 women aged 19-61 years. These figures are higher than those from a similar study in 1985 conducted among a larger group of affluent urban Thais aged 35-54 years.[41]

For the adult population in Malaysia, 20.7% are overweight with a BMI between 25.0 kgm^{-2} and 29.9 kgm^{-2}; a further 5.8% are obese with a BMIs ≥30 kgm^{-2}. There was a slightly higher prevalence of overweight amongst women (21.4%) compared to men (20.7%) whereas the problem of obesity amongst women (7.2%) was twice that of men (3.8%).[42] Singapore, a multi-ethnic society with a population consisting of three main ethnic groups: Chinese (77%), Malays (14%), and Indians (7.6%), has a lower prevalence of obesity than Malaysia (BMI ≥30 kgm^{-2}) according to the 1997 data reported in a WHO conference. Within the Singaporean population, the Malays have the highest prevalence of obesity, followed by the Indians and Chinese. The prevalence of obesity within Singaporean

Chinese population is 3.2% for males and 3.9% females.[43] In the 1998 National Health Survey of Singapore, 24.4% of the population were overweight and 6% were obese. The prevalence of overweight was higher amongst the men (male: 28.6%; female: 20.3%), whereas there was a slightly higher proportion of obese women (males: 5.3%; female: 6.7%).[43] The mean BMI in Singapore is comparable with the mean BMI in the three big cities in China.[44]

According to a study targeting an elderly population of Taiwan, 27.3% of the male population and 34.9% and female population are found to be overweight using BMI ≥23 kgm^{-2} and 3.2% of the male population and 6.4% of the female population are determined to be obese using BMI ≥25 kgm^{-2}. The prevalence of obesity for elderly men and women in Taiwan was lower than that in Kuwait, Sweden, the United States, and the Native Americans, but higher than in Japan.[45] In China, the prevalence of obesity is low but the percent of obese population is continuing to rise. Although the prevalence of obesity in Chinese subjects ≥20 years of age was lower than that of other countries, approximately one-third of the subjects were overweight and had an abnormal body fat distribution.[46] In 1992, the prevalence of obesity in China was 1.2% of male population and 1.6% of female population.[43] The national nutrition surveys conducted between 1982 and 1992 showed that the prevalence of overweight and obesity in young adults increased from 9.7% to 14.9% in urban areas and 6.2% to 8.4% in rural areas during the 10-year period. The increased rate was 53.6% for urban residents and 36.6% for rural resident.[47] Even though the obese population in China is not outrageously high, the absolute increase of obese population by 1% in China corresponds to many millions of obese people. According to the result obtained from a large-scale population-based survey in Hong Kong, the prevalence of obesity (BMI ≥30 kgm^{-2}) was 5.4% and 7.0% in men and women, and approximately 33% of the subjects had a BMI ≥25 kgm^{-2}.[48] Based on the 1997 Hong Kong Census statistics data of the overall Hong Kong population, the age-standardised prevalence rates of overweight and obese subjects were 30.52% and 3.19% in men and 22.14% and 3.35% in women, respectively.[49]

Childhood and Adolescent Obesity

Not only does the increase in adult obese population needs attention, the increase in the prevalence of obesity in children is equally alarming. For American children aged 6 to 11 years, the prevalence of overweight nearly doubled from 1980 to 1994 (i.e. from 6.5% to 11.4% in boys and from 5.5% to 9.9% in girls).[50] Data from a nationally representative sample of 2,630 English children showed that the frequency of overweight ranged from 22% at age 6 to 31% at age 15 years and that of obesity ranged from 10% at age 6 to 17% at age 15 years.[51] For Australian children and adolescents, the secular trend of increasing overweight and obesity in the decade from 1985 and the high prevalence rates are a major public health concern. In the year 1985 sample, 9.3% of Australian boys and 10.6% of Australian girls were overweight and a further 1.7% of boys and 1.6% of girls were obese. In the 1995 sample, overall 15.0% of boys and 15.8% of girls were overweight and a further 4.5% of boys and 5.3% of girls were obese.[52]

The estimate of overweight reported by WHO amongst preschool children in Asia in 1995 was 2.9%, with a higher prevalence of 4.3% in Eastern Asia and 2.4% in Southeast Asia.[47] One study, which aimed to quantify the prevalence of overweight and obesity in 10- and 15-year-old children, confirmed that overweight in older children is no longer confined to Western countries only. The prevalence of total overweight (overweight or obesity) in 10-year-old ranged from 4.5% in the Netherlands to 29.6% in Italy for boys and ranged from 6.7% in the Netherlands to 31.4% in Italy for girl. Among the 15-year-old, the prevalence of total overweight in boys ranged from 5.8% in the Netherlands to 30.5% in Taiwan and in girls from 6.3% in Hong Kong to 21.1% in Taiwan.[53]

In a Japanese city, one study showed that the frequency of obese school-children (>120% standard body weight, SBW) aged 6-14 years increased from 5% to 10% and that of extremely obese children (>140% SBW) from 1% to 2% during the 20 years from 1974 to 1993. Another important finding of this study suggested that approximately one-third of obese children grew into obese adults.[54] Increasing intake of fat is one of the reasons contributed to the increasing number of obese children in Japan.[55] A study based on Japanese children indicated that severe obese children have a higher risk of becoming obese adults even when they received obesity treatment in childhood. Also, the risk of adulthood obesity was twice as high in moderately obese boys than in girls.[56] Obesity in childhood and adolescent is a significant predictor to adult obesity. The risk of adult obesity for children of obese parents was shown to be significantly greater than those with non-obese parents.[57]

The prevalence of childhood obesity has increased

dramatically in Taiwan in the past 40 years. No primary school children were considered obese in a nutritional survey done in 1954. A slight increase in the prevalence was seen in a study done in 1970 showing that 2% of school children were obese. In 1988, a national survey reported that the prevalence of obesity was up to 17% of children and adolescent. In 1991, a cross-sectional survey involving 1168 junior high students indicated that 15.0-17.3% of males and 14.8-15.6% of females were obese.[58] Along with other results,[59] an increasing trend is observed in children's average body weight and BMI, as well as the prevalence of obesity, during the period 1954-1991. From 1980 to 1994, the mean value of body weight for Taiwanese children increased significantly (especially among boys). Also, the prevalence and trends of obesity increased significantly, especially among boys and older girls.[60] Obese children were about five times as likely to have an obese parent as control and there was a significant difference in the chance of having an obese sibling between the obese and the control group.[61]

Similar to the adult data, the prevalence of overweight children in China is slightly lower than other parts of Asia. In the 1992 national nutrition survey of China, 6.5% of urban children and 4.9% of rural children were observed to be overweight under the age of 5 years.[44] In the 1998 nationwide surveillance involving a larger sample size of 6-year-old children and the same criteria, 5.2% of urban children and 3.5% of rural children were classified as overweight.[62] Another study done in 1996 involving 109 701 urban Chinese children in China, the prevalence of children aged 0-7 years with weight over 120% of the reference weight for height was 1.76%. The 6-7 years age group has the highest prevalence, where 5.4% of boys and 2.8% of girls were found to be overweight.[62]

Assessment of Obesity

There are many methods for assessing the fat content of an individual. Direct measurements of body fat content, such as hydrodensitometry, bioelectric impedance, or dual-energy X-ray absorptiometry, are useful tools in scientific studies but they are complicated to performed. Body mass index (BMI, weight/height^2; kg/m^2) is the commonly utilised tool in epidemiological studies for categorising adult obesity. BMI, a graded classification of overweight and obesity in adults, provides meaningful comparison of weight status within and between populations and the identification of individuals and groups at risk of morbidity and mortality. The classification of overweight and obesity has been proposed by the WHO expert committee, which is applicable to both men and women and in the adult age group. Based on the population of western countries, WHO guidelines issued in 1997 suggested that a BMI of 25 kgm^{-2} or greater is classified as overweight and 30 kgm^{-2} or greater is classified as obese.[43]

However, this measure may not be applicable in many Asian countries where there are low prevalence of obesity, but relatively high rates of obesity-related diseases. Most Asian populations have a higher body fat content for a given BMI than European.[63] Result of body composition studies showed that Asian have a lower BMI but higher percentage of body fat than Caucasians. There is also a difference in the fat distribution between Asian and Caucasians.[64-68] Asians seem to have more upper-body subcutaneous fat than do whites.[63] Therefore, the cut-off mark for the classification of obesity will need to be different from those currently recommended by the WHO. The range for acceptable, normal, or optimum BMI for Asian populations should be narrowed to 18.5-23 kgm^{-2}, according to a WHO expert consultation on appropriate BMI for theses populations that took place in Singapore.[69]

BMI has also been proposed as a good clinical measure for the definition of obesity in children and adolescents. However, BMI varies with age and gender which means that a series of age-related and gender-related norms are needed. Also, changes in BMI during early childhood may vary between different ethnic groups which means that ethnic-specific BMI reference values may be needed.[70-73] It has been proposed that the adult BMI cut-off in Asian of 23 kgm^{-2} (25 kgm^{-2} for Caucasian) for overweight and 25 kgm^{-2} (30 kgm^{-2} for Caucasian) for obesity should be extrapolated into a childhood BMI/age percentile chart to establish the BMI percentile cut-off values for overweight and obesity in childhood and adolescence. These cut-off values for overweight and obesity correspond roughly to the 85th and 95th percentile for the Hong Kong Chinese BMI chart.[74]

According to a US Expert Committee, it is recommended that children with a BMI ≥85th percentile with complication of obesity or BMI ≥95th percentile with or without complication undergo evaluation and possible treatment.[70] According to Dietz and Bellizzi,[75] very few children are incorrectly classified at the 95th percentile, although it is possible that some children with excess adiposity will fall below the 95th percentile and be missed in screening. To

reduce the chance of missing at-risk children, an additional BMI cut point at the 85th percentile was established. These cut-off points based on American population are not representative and are arbitrary if used in other populations. BMI cut-off ranges for overweight and obesity with age was established based on an international BMI reference constructed from six representative population growth studies (Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States).[76]

However, one UK study[77] found that the ability of the international cut-off to identify obese children was low as compared to the UK 1990 BMI reference data.[72] The result of this study suggested the international cut-off points for BMI for overweight and obesity by sex between 2 and 18 years is linked to the widely accepted adult cut-off points of a BMI of 25 and 30 kgm^{-2}.[72] The "international" reference and USA reference of BMI can give different estimates for obesity for different ethnic groups. One should be caution when comparing results based on different references.[78]

This "international BMI reference" was used by Bellizzi et al[79] for the comparison of the prevalence of overweight and obesity in 10-year-old and 15-year-old children from Europe and Asia as shown in the following tables (Tables 1 & 2).

These results suggest that Hong Kong does have a problem with childhood and adolescent overweight although the prevalence of obesity is still not particularly high. In contrast to western societies, the prevalence of childhood and adolescent overweight and obesity is higher in males as compared to females in Asian societies. However, the prevalence of overweight and obesity of Hong Kong children is based on data collected 10 years ago and up-to-date data is obviously required to reflect the current situation. In a small study of 404 secondary students aged 12 to 18 years published recently in Hong Kong, 16.37% of the girls and 9.44% of the boys were found to be overweight.[80]

Medical Complications of Obesity

Obesity is a complicated disorder, which involves multiple organ systems and can lead to potentially devastating consequences. It is considered as an important predictor of long-term morbidity and mortality. Generalised obesity results in alterations in total blood volume and cardiac function, whereas the distribution of fat around the thoracic cage and abdomen restricts respiratory excursion and alters respiratory function. The intra-abdominal visceral deposition of adipose tissue, which characterises upper body obesity, is a major contributor to the development of hypertension, elevated plasma insulin concentrations and

Table 1 Prevalence of overweight and obesity in 10 years old children from Asian and Europe based on Bellizzi et al.[79]

	Boys		**Girls**	
	Overweight (%)	**Obese (%)**	**Overweight (%)**	**Obese (%)**
Japan	21.7	6.1	17.4	1.0
Singapore	19.4	6.1	14.6	3.0
Hong Kong	15.6	4.7	8.3	1.8
U.K.	8.1	1.4	13.0	1.3
Netherlands	4.5	0.0	6.1	0.5
Germany	19.4	3.5	15.7	1.9

Table 2 Prevalence of overweight and obesity in 15 years old adolescents from Asian and Europe based on Bellizzi et al.[79]

	Boys		**Girls**	
	Overweight (%)	**Obese (%)**	**Overweight (%)**	**Obese (%)**
Japan	14.3	5.7	13.9	1.8
Singapore	11.4	3.9	8.6	2.9
Hong Kong	7.0	3.3	5.3	1.0
Taiwan	23.2	7.3	17.9	3.2
U.K.	6.3	0.7	7.6	0.0
Netherlands	5.6	0.2	8.1	0.5

insulin resistance, diabetes mellitus and hyperlipidaemia.[20,37] Evidence suggested that there is an increased risk of mortality from all causes among overweight adolescent subjects. The major obesity-related comorbidities included metabolic syndrome (e.g. insulin resistance, hyperinsulinaemia, dyslipiaemia, essential hypertension, type 2 diabetes),[81] cardiovascular complications (e.g. ischaemic heart disease, stroke),[82,83] pulmonary complications (e.g. obstructive sleep apnoea syndrome), and musculoskeletal problems (e.g. orthopaedic abnormality) and possibly some forms of cancers.[84] There is a significant relationship between obesity and hypertension, hypercholesterolaemia, low high-density lipoprotein (HDL) cholesterol, hypertriglceridaemia, hyperinsulinaemia, type 2 diabetes mellitus, and many clotting and haemostatic condition.[20] Besides these major complications, gastroesophageal reflux, polycystic ovary syndrome, gallstones, urinary incontinence, and skin disorders (acanthosis nigricans, acne, intertrigo, hirsutism) are also obesity-related medical sequelae common in obese subjects.

Although short-term mortality is rarely associated with childhood or adolescent obesity, childhood obesity is considered as an important predictor of long-term morbidity and mortality. The complications of adult obesity are mainly metabolic and mechanic consequences whereas those associated with childhood obesity are slightly different. The common complications include psychosocial problems, hyperlipidaemia, hepatic steatosis, carbohydrate metabolism abnormality and the fact that the conditions will persist into adulthood. Rare complications include orthopaedic problems, sleep apnoea, pseudotumor cerebri, polycystic ovaries, cholelithiasis and hypertension.

Type 2 Diabetes Mellitus

Obesity is a recognised risk factor for the development of type 2 diabetes mellitus (non-insulin dependent diabetes mellitus) according to many animal models of obesity, which lead to morbidity and mortality of all age group. Type 2 diabetes mellitus is considered as a population epidemic as all diabetic patients are at risk of acquiring diabetes-related complications. Under the subdivision of microvascular complications, the principal sites of damage are the eye, the kidney and the nervous system which lead to retinopathy, nephropathy, and neuropathy respectively. Clinical consequences are blindness, renal failures and foot problems causing risk of amputation. On the other hand, macrovascular complications are usually non-specific and not unique to diabetes only but occur at a higher rate in diabetic individuals. As main vessels supplying the heart, the brain and the legs are impaired, heart attack, stroke and gangrene are more commonly seen in diabetic subjects. Central obesity, which is characterised by the intra-abdominal localisation of excess adipose tissue and clinically manifests as an increase in the waist circumference, increases the risk of developing type 2 diabetes mellitus. High daily calorie intake and limited physical activity leading to obesity which is found in 70% of type 2 diabetes mellitus patients. Weight gain, the degree of obesity, and the duration of obesity are all strong independent predictors of the risk of type 2 diabetes.[85] Comparatively, women with a BMI of 23-25 kgm^{-2} have a 4-fold higher risk of type 2 diabetes than those with a BMI <20 kgm^{-2}. Those with a BMI of 24-25 kgm^{-2} have a 5-fold increased risk and those with a BMI >35 kgm^{-2} increases the risk of developing type 2 diabetes 93-fold.[86] Impaired glucose tolerance (IGT) and type 2 diabetes mellitus can be considered as different spectrum of the same disorder. IGT is the best predictor for subsequent development of type 2 diabetes mellitus.[87]

Increasing incidence of type 2 diabetes mellitus in both children and adolescents has been documented in the United States,[88,89] Europe[90,91] and various part of Asia[58,92-95] with exceptional large number of cases in some communities in developing countries.[96] The American Diabetes Association has identified diabetes as a major public health problem of epidemic proportions associated with obesity, with about 800 000 new cases in the United States annually. There is also a sharp increase in the prevalence of diabetes among the nation's children and adolescence.[97]

Cardiovascular Diseases

Type 2 diabetes mellitus is a not the only medical hazard of obesity; the combination of type 2 diabetes mellitus and high BMI in patients increase the risk of developing cardiovascular diseases. Cardiovascular complications of childhood obesity are similar to those with adults, including dyslipidaemia, hypertension, chronic inflammation, increased blood clotting tendency, endothelial dysfunction, and hyperinsulinaemia. Numerous studies have reported that obese individuals have an abnormal "atherogenic" lipid profile consisting of elevated serum low density lipoprotein (LDL) cholesterol, triglycerides and total cholesterol to high density lipoprotein (HDL) cholesterol ratio and decreased HDL cholesterol concentration in both Caucasian and Chinese population.[98-103] The triad of hyperinsulinaemia, high apolipoprotein B, and small, dense LDL particles is

associated with a 20-fold increase in the risk of coronary heart disease.[104] Studies which investigated various Asian population for examples, Hong Kong, China, and Singapore, documented that manifestation of cardiovascular risk is shown to be lower in subjects with a lower BMI value[33,46,100,104] In a cross sectional study of 271 primary school children between 9 to 12 years of age in Hong Kong, overweight/obese children were taller and had higher systolic blood pressure, fasting insulin, higher triglycerides and lower high density lipoprotein-cholesterol than non-obese subjects.[105] Nearly 50% of the obese Chinese children were found to have at least two of these cardiovascular risk factors in this study by Sung and coworkers fulfilling the diagnosis of the metabolic syndrome which predicts both type 2 diabetes mellitus and premature coronary heart disease.

Hypertension

The widely recognised relationship between obesity and hypertension was evidenced by different studies. Experimental studies have shown that weight gain raises blood pressure. Clinical studies have shown that weight loss is effective in lowering blood pressure in most hypertensive patients, and population studies have shown that excess weight gain is one of the best predictors for development of hypertension.[104,106-108] Epidemiology from the American Heart Association showed that approximately one-quarter, or even one-half, of the obese population suffer from hypertension and the risk estimation suggested that as much as 75% of the hypertensive population in the US can be attributed to obesity.[97] Although the mechanism between increase body weight and hypertension is still unclear, the association is believed to be related to renal dysfunction. Obesity increases renal sodium reabsorption and impairs pressure natriuresis by activation of the renin-angiotensin and sympathetic nervous systems and by altered intrarenal physical forces. Chronic obesity also causes marked structural changes in the kidneys that eventually lead to a loss of nephron function, further increases in arterial pressure, and severe renal injury in some cases.[104] Adverse dietary factors, e.g. alcohol, sodium/potassium intake and calorie-dense food item, play an important role on body weight maintenance.

Obstructive Sleep Apnoea Syndrome

Obstructive sleep apnoea syndrome (OSAS) is another medical consequence of childhood obesity that requires attention as a large number of adult obese patients have been found to have OSA. This disorder is characterised by recurrent episodes of cessation of respiratory airflow during sleep due to excessive fat in the neck causing collapse of the upper airway at the level of the pharynx.[109] Affected respiratory function in obesity results from a combination of mechanical impedance to breathing exerted by thoracic and abdominal fat and a ventilation perfusion mismatch. The vital capacity and total lung capacity are frequently decreased. The ventilation perfusion mismatch due to underventilation of the wall lower lobes of the lung is affected by varying degrees of hypoxia. In rapid eye movement (REM) sleep, there is a decrease in voluntary muscle tone and respiratory responses causing hypercapnia and hypoxia. Hence, hypoventilation is a problem in obese individual while asleep. Affected obese children will snore, choke, pause and gasp during sleep. Affected children may have frequent awakening at night and nightmares, requiring to sleep propped up and have disturbed physiological function like nocturnal enuresis. The poor quality of sleep often results in daytime somnolence, with neurocognitive defects including lapses in concentration and memory.[110] It is approximated that about 50% of OSAS patients have a BMI value greater than 22 kgm^{-2}.[110] Thirty percent to 40% of obese men experience snoring during sleep while it is present in 15% to 25% of non-obese men.[111] In a recent study from Hong Kong involving 46 obese children, 26% of these obese children had sleep-related disordered breathing.[112]

Orthopaedic Diseases

Excess body mass also appears to have an adverse effect on the foot structure of children where young obese children display structural foot characteristics, which may develop into problematic symptoms if excessive weight gain continues.[113] The associated orthopaedic diseases include bilateral tibia vara (bowed legs which result in knee pain and affects mobility), slipped capital femoral epiphyses, which causes hip pain and arise from abnormal forces acting on the femoral growth plate, and pes planus, which is caused by poor foot arches.[110] The feet, which are the base of support of the body, are continually exerting forces generated from daily living activities. With increased body weight, it is obvious that it would result in higher plantar foot pressures. Many of the orthopaedic conditions that are manifested in obese adults may be the consequence of an excessive and prolonged exertion of force. High levels of body fat plus increased loads on the major joints have the potential to lead to pain and discomfort, inefficient body

mechanics and further reductions in mobility. In order to minimise joint deterioration from excessive joint loading, any mal-alignment or mal-functioning of the lower limbs evident in obese children should be treated at the earlier possible opportunity.[114] A study investigated the effects of obesity on plantar pressure distributions in prepubescent children concluded that foot discomfort-associated structural changes and increased forefoot plantar pressures in the obese foot may hinder obese children from participating in physical activity.[115]

Psychological Complications of Obesity

Apart from those obesity-related medical problems, obesity also has an impact on psychosocial well-being, longevity, and quality of life. Obesity, in a way, is creating an enormous psychological burden on suffering individuals. Obese children of our society are often prejudged as unhealthy, academically unsuccessful, socially unaccepted, unhygienic, and lazy. The psychological impacts on these children include negative self-image, low self-esteem, and poor quality of life.[116]

Quality of Life and Self Esteem in Adults

In the simplest manner, quality of life refers not only to health status, but also to environmental and economic factors (e.g. income, educational attainment) that can substantially affect well-being.[117] The term, quality of life, is defined medically as the individual's abilities and needs to pursue daily activities. Quality of life is also the individual's overall satisfaction with his life, based on his own values, goals, abilities, and needs.[118] The negative impact of obesity on physical well-being and on psychosocial functioning in adults has been well established. Gender difference may also play a role in modifying the psychological risk of obesity. Obese women (BMI >34 kgm^{-2}) were found to have more significant psychosocial consequences of obesity than obese men (BMI >34 kgm^{-2}).[119] A study done on a general population reported that more frequent incidence of major depression, suicidal thoughts and suicide attempts were present in women with excess weight. Contrarily, men with excess weight had a decreased risk of depression and suicidal behaviour.[120] Self-perception of overweight was more common in women compared with men and in whites compared with blacks or Hispanics.[121]

Both nonclinical- and clinical-based studies have demonstrated that there is a positive relationship between obesity and negative body image and low self-esteem. By early adolescence, obese Hispanic and white females demonstrated significantly lower levels of self-esteem.[121] Obese young adults with decreasing levels of self-esteem often demonstrated significantly higher rates of sadness, loneliness, and nervousness and are more likely to engage in high-risk behaviours such as smoking or consuming alcohol.[122] Prejudice is always present in our society, which place discriminating perspective on overweight and obese people, which in turn affects multiple aspects of their lives. Among obese individuals, body image dissatisfaction is the commonest psychosocial issue encountered.

Impacts on Children and Adolescents

Obese children and adolescents often experience incidents of weight-teasing in school, street, and in family and they are bothered by the teasing episodes. Weight-teasing is associated with disordered eating behaviours that may place overweight youth at increased risk for weight gain. Among 4,746 adolescents from a public school in the United States, 63% of very overweight girls and 58% of very overweight boys (using BMI ≥95th percentile) reported being teased by their peers, while weight-teasing by family members was reported by 47% of these girls and 34% of these boys. This study also suggested that perceived weight-teasing was significantly associated with disordered eating behaviours among overweight and non-overweight girls and boys. For example, among overweight youth, 29% of girls and 18% of boys who experienced frequent weight-teasing reported binge-eating as compared to 16% of girls and 7% of boys who were not teased.[123]

Sex, age, and ethnicity play an important role in global psychosocial concerns, such as emotional well-being, suicidal ideation, future job concerns, and peer concerns, and health-compromising behaviours. These psychosocial factors did not differ greatly between non-overweight, moderately overweight, and severely overweight adolescents. Alcohol consumption and marijuana addiction were less prevalent in overweight girls and boys, respectively, compared to non-overweight group. However, overweight adolescents tend to perceive their health more negatively than non-overweight adolescents and express more weight-specific concerns and engage in behaviours such as chronic dieting and binge eating. Overweight American Indian girls perceived their physical health more positively than non-overweight American Indian girls. There were strong associations found between overweight status and chronic dieting among African American boys

and girls.[124] Relative body weight was found to be associated with major depression, suicide attempts, and suicide ideation but these relationships were different for men and women. Among women, increased BMI was associated with both major depression and suicide ideation. Among men, lower BMI was associated with major depression, suicide attempts, and suicide ideation.[120] Depression during childhood has been shown to be positively associated with BMI during adulthood. However, this association could not be explained by a number of potentially confounding factors, including age, gender, cigarette or alcohol use, social class, and pregnancy or medication history.[125] Psychosocial distress and psychiatric disorder in children and adolescents may be more associated with parental psychosocial and psychiatric problem than the child's own BMI, age, or sex.[126] Low social class of the child's family, a high maternal BMI before pregnancy, a high BMI during adolescence, and early menarche are predictors of obesity in adulthood.[127] Obese children and adolescents have an increased risk of psychosocial and psychological problems that can persist into adulthood.[128]

Binge Eating Disorder

Overweight children and adolescent have some psychological features which is possibly associated with the development of binge eating disorders, for example a link between concerns and self-esteem based on physical appearance. Binge-eating habit is thought to be one of the psychosocial problems that lead to obesity.[129-133] Binge eating disorder refers to a pattern of recurrent binge eating episodes without the regular use of the compensatory behaviours seen in bulimia nervosa (e.g. vomiting, dietary restriction, and laxative use) and binge episodes are characterised by both the large amounts of food consumed and the associated feelings of loss of control.[134] Binge eating disorder is associated with higher rates of psychopathology, in particular depression.[135]

The prevalence of binge eating disorder is reputed to occur in approximately 1.5-2% of the people in the community.[132] Approximately 10-30% of obese persons who seek weight reduction suffer from binge eating.[129] Only few studies about binge eating among obese adolescents have been published. The study conducted in a population of 52 obese youngsters aged 13-19 years, binge-eating habit is present in 18% of the boys and 27% of the girls.[134] Another study, which employed a diagnostic interview to evaluate binge eating of 51 obese girls aged 14-16 years, found that 30% of them posses binge eating episode.[136] Among a population of obese young adults (age range, 15-21 years) studied 57% of females and 35% of the males were detected to have binge-eating habit.[135] Finding from a study that investigated the occurrence of binge eating within 126 obese subjects (aged 10-16 years) concluded that 35.3% of boys and 37.3% of girls present with binge-eating episodes.[137] Strong familial relationships have been shown to decrease the risk for eating disorder among youth reporting abuse experiences, but both sexual and physical abuse are strong independent risk factors for eating disorder among both adolescent girls and boys.[138]

Interventions

As the prevalence of obesity and obesity-related physiological and psychological impacts are increasing globally, obesity prevention has become an international public health priority. Prevention of childhood obesity focuses on dietary education and physical activity intervention. Numerous long-term and short-term studies have been conducted to assess the effectiveness of educational, health promotion and/or psychological/family/behavioural therapy/counselling/management interventions that focussed on diet, physical activity and/or lifestyle and social support to prevent obesity in children. However, the outcome is not particular promising. The long-term studies intended to reduce the percentage of obesity and overweight among children by dietary education and/or physical activity intervention failed to reach any significant difference[139-143] while some of the short-term studies showed significant reduction in BMI,[144,145] triceps skinfold thickness, waist circumference and waist-to-hip ratio.[145]

Although intervention programs for preventing obesity do not always yield sustained results, several studies have reported positive dietary and lifestyle changes among these children and adolescents. These changes included decrease in total energy and fat intake, increase carbohydrate and fiber intake,[141,146] decrease in daily saturated fat, lower percentage of calories from fat,[146] decrease in television viewing and number of meals eaten in front of the television.[145,147] In a cochrane review, there is currently limited high quality data on the effectiveness of obesity prevention programmes. Encouraging reduction in sedentary behaviours and increase in physical activity should be emphasised in order to minimise the prevalence of obesity and overweight in both adult and childhood population.[148]

Conclusion

Although the psychological concerns associated with obesity have been explored in many studies in different countries, no information is available, which investigates the psychological concerns within the Hong Kong paediatric obese population. Targeted screening for type 2 diabetes in obese individual with a family history of type 2 diabetes mellitus, acanthosis nigricans or other clinical evidence of insulin resistance should be worthwhile[149] and studies on both the metabolic and psychological sequalae of childhood and adolescent obesity in Hong Kong are warranted.

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