Review Article

An International Perspective on Obesity, Health and Physical Activity: Current Trends and Challenges in China and Asia

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Obesity is the most widespread global metabolic disease and is a significant public health problem. During the last three decades, many countries in Asia are facing a looming health crisis of obesity because of rapid modernization, dramatic changes in lifestyle, high fat and sugar diet, and reduced physical activity resulting partly from the Western lifestyle. However, the lack of comprehensive data on obesity issues in Asia makes it difficult to design and implement effective interventions. The aim of this review article is to document the current trends in obesity in Asian countries from an international perspective, with an emphasis on the current changes in Asia, including the historical aspects, role of genetic factors, changes in diet and physical activity patterns, health complications of obesity, trends in the prevalence of obesity across Asia, and current methods of evaluation and treatment regarding obesity. This review will help our understanding of obesity patterns and risk factors in Asian populations. The results of this review will have important implications for future development of culturally appropriate and effective interventions.

Keywords: Asia, nutrition, obesity, physical activity

Introduction

At the beginning of the third millennium, obesity became the most frequent global metabolic disease (McLellan 2002). Increasing prevalence has been shown not only in the industrially developed countries, but also in the developing countries. This concerns all age categories, including children, because of the westernization of dietary behavior and dietary lifestyles (Flynn et al. 2006; Lobstein et al. 2004; Loke 2002; Wellman & Friedberg 2002; Deckelbaum 2001; Magarey et al. 2001; Martorell et al. 2000; WHO 2000, 1998), and the prevalence of obesity varies remarkably across countries with different socioeconomic development levels (Popkin 2006; Vijayalakshmi et al. 2002; Wang 2001). Indeed, World Health Organization (WHO 2002, 2000, 1998) data from the Global Database on Obesity and Body Mass Index (BMI) showed that global obesity (BMI > 30 kg m^{-2}) was 8.7% (or 300,000,000) in adults in 84 countries in

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1999–2000. Odgen et al. (2006) reported a significant increase in the prevalence of overweight among children and adolescents (from 13.9% to 17.1%) and of obesity among adults (from 30.9% to 32.2%) during the 6-year period from 1999 to 2004 in the United States. This also represents an economic problem with respect to accompanying health problems and expenses for treatment (Levy et al. 1995). In the US, the total cost of overweight and obesity in 2000 by some estimates was $117 billion, with $61 billion direct and $56 billion indirect costs (Wolf & Colditz 1998). The developing countries, owing to their large populations, accounted for 39% of the total global prevalence of obesity (Florentino 2002). Transitions in diet and nutrition and changes in activity patterns fuel the obesity epidemic (Popkin 2006; Popkin & Gordon-Larsen 2004; Maire et al. 2002; Schmitz & Jeffery 2002; Popkin 2001a & b; Holmboe-Ottesen 2000).

Obesity prevalence has increased in the adult population and in children in China (Wu 2006; Chen et al. 2005; Li et al. 2005; Ma et al. 2005; Wu et al. 2005; Cheng 2004; Ma et al. 2004; Wu et al. 2002), and elsewhere in Asia (Rashidi et al. 2005; Mohammadpour-Ahranjani et al. 2004; Thomas et al. 2004; Fatimah et al. 2002; Florentino 2002; Ismail et al. 2002; Kanazawa et al. 2002; Levine et al. 2002; Tee 2002; Yoshiike et al. 2002; Lim et al. 2000). Markedly, the prevalence of obesity is unequally distributed between urban and rural populations. In China, according to data collected from the 2002 National Nutrition and Health Survey, urban and rural obesity rates were 25.0% and 12.8% respectively (The State Council Information Office 2004).

The overweight and obesity problem should have affected nearly one-quarter of the country's total population (Wu et al. 2005). In Indonesia in 1993, overweight adults made up to 21.5% of the population in the urban areas and 7.5% in the rural areas (Lobstein et al. 2004; James 2002; International Obesity Task Force [IOTF] 2000). In Vietnam, in the early stages of socioeconomic transition in 1992–93, the prevalence of overweight and obese people was estimated at 2% in the rural areas but was double that in the urban areas (Gillespie & Haddad 2001). Shifts in transportation patterns occurring in urbanized populations and an increased dietary intake of energy-dense foods and high fat meals provide an opportunity for increasing weight and fatness (Bell et al. 2002). "Thrifty genes", which contributed to the economization of energy management and helped individuals to survive under conditions of malnutrition during human phylogeny, are considered as one of the causes of the recent increasing prevalence of obesity in the Third World when the economic level improves (Neel 1999). In more developed countries in Asia, like Japan, the reported prevalence of overweight adults was 26.8% for males and 21.2% for females (Yoshiike et al. 2002), which reached one-fifth of Japanese adults (Yoshiike et al. 1998).

The problem of obesity has become a national concern for many countries and has been increasing over the years (Han et al. 2003), especially when considering children and adolescents among whom obesity prevalence has increased significantly during recent times (Goran & Sothern 2006; Parizkova & Hills 2005; Lobstein et al. 2004; Mohammadpour-Ahranjani et al. 2004; Fu et al. 2003a; Fatimah et al. 2002; Ismail et al. 2002; Bell et al. 2001; Parizkova & Hills 2001; Epidemiology and Disease Control Department, 1999). Wang et al. (2005) point out that an obesity epidemic in China is imminent, with more than 20% of children aged 7–17 in big cities now overweight or obese. Ji et al. (2004) also reported that most of the Chinese metropolises such as Beijing have started the so-called "overall increment period" since 2000. The prevalence rates of obesity for boys aged 7–12 years range between 9.1% and 12.9%, which has already reached the average level seen in the medium-developed countries in the world.

Although obesity has received increasing attention in Asia in recent years (Cameron et al. 2006; Goran & Sothern 2006; Parizkova & Hills 2005; Burniat et al. 2002; Parizkova & Hills 2001), the lack of comprehensive data on obesity issues in Asia makes it difficult to design and implement effective interventions. The aim of this review article is to document the current trends in obesity in Asian countries from an international perspective, with an emphasis on the current changes in Asia, including the historical aspects, role of genetic factors, changes in diet and physical activity patterns, health complications of obesity, trends in the prevalence of obesity across Asia, and current methods of evaluation and treatment regarding obesity. We hope this review will help us understand the obesity patterns and risk factors in the Asian population. The results of this review will have important implications for future

development of culturally appropriate and effective interventions.

Historical aspects

Obesity has accompanied human development since prehistoric times, even though the major challenges humans faced in those times were malnutrition and search for food. For example, ancient arts like the sculptures of Venus depict gynoid-type of obesity (i.e. increased deposition of fat over lower trunk and thighs). In the Paleolithic period, many female figures featured abdominal obesity and pendulous breasts, which symbolized the expression and possible esthetic ideals of wellbeing and fertility (Bray 2004; Bray 1998; Hautin 1939). These figures have been found in France, Italy, Austria, and Russia, as well as in Egypt and Asia. Though they are composed of different materials, the similarity in design and structure indicate that obesity was already a fact of life at least for Paleolithic women (Bray 2004; Hainer et al. 1999; Bray 1998).

Increased fatness affected those with access to abundant food—namely, the wealthy and the powerful. Thicknesses of subcutaneous fat of mummies of Amenhotep III and Ramses III showed that these rulers were obese. Other emperors and privileged members of society from other empires were also obese, e.g. in China, along with eventual comorbidities. Since medical traditions are an integral part of all societies, many procedures were documented on how obesity-related ailments were treated. Acupuncture, the art of treatment by inserting sharp needles into the body, was developed and reached its zenith in China. The technique of placing sharp objects in the pinna of the ear to reduce "appetite" has been used to treat obesity. Tibetan medicine, an offspring of Chinese medicine, emphasizes that overeating causes illnesses and results in earlier death. Historically, two common practices were used in the treatment of obesity: (1) vigorous massage of the body with pea flour, which also counteracts phlegm disease and (2) the gullet, hair compress and flesh of a wolf remedy, which were also used for goiters and dropsy (Tibetan Medical Paintings 1992).

Obesity is represented in many advanced cultures where wealth and wellbeing were common. Even then, the relationship between overweight and deteriorating health status was well known. In ancient Greece and Rome, lean athletes represented an ideal; on the other hand, many wealthy subjects were overweight and obese and suffered from various health problems. A healthy diet was prescribed and increased physical activity was recognized and recommended for the improvement of health and longevity in the ancient Roman Empire (Hainer et al. 2004). Medical doctors who took care of the privileged—the rulers, aristocracy, etc.—during the later centuries intended to work on recommendations for a healthy diet and lifestyle that ensured a good quality of life and longevity (Hainer et al. 2004). In India, the sacred medical text, Ayurveda, recommended the administration of testicular tissue as a cure for obesity as well as impotence (Iason 1946). A Chinese book, Hung Tu Hei Ching (Yellow Emperor's Inner Canno) dated from 200 BC, was a dialogue on bodily functions and disease (Alphen & Aris 1996).

During the Middle Ages, feudal aristocracy enjoyed rich food and had low levels of physical activity—except for hunting and other forms of physical entertainment like dancing. In the baroque period in Europe, an ideal woman was plump, rather obese, according to present-day norms. This contrasted with the puritan traditions of the Contemporary Church, which proclaimed Ascetism and where priests were often obese. In China, historically, the ideal beautiful woman was slim, as revealed by many paintings and sculptures.

Changes in obesity prevalence in Asia

Recent studies and reports show that obesity in China and in many parts of Asia has increased (Wu 2006; Hui et al. 2005; Cheng 2004; Rajan 2004; Walsh 2004; Du et al. 2002; Florentino 2002; Fu & Hao 2002; Tee 2002; Wu et al. 2002; Cheng 2001; Fu 2001; Popkin 2001a & b). In a recent WHO report (2002), six Asian countries—China, India, Indonesia, Japan, Pakistan, and Bangladesh—are listed among the top 10 countries with the greatest prevalence of the disease. The overweight and obesity rates of Chinese adults have reached 22.8% and 7.1% with an estimated 200 million and 60 million who suffer from overweight and obesity, respectively (The State Council Information Office 2004). A study conducted by Chen et al. (2005), who used a questionnaire

survey and physical examination of 29,056 adults aged between 35 and 85 years from 14 densely residential areas in 14 provinces/municipalities in China, reported a more unfavorable result of total prevalence of overweight and obesity of 37.17% and 13.94%, respectively. One-sixth of the citizens in Guangdong Province (Ma et al. 2004) and 35.1% of Beijing residents (Pang et al. 2005) were considered to be overweight. From a study on the epidemiologic characteristics of obesity in Chinese adults, Wang et al. (2001) reported that among 11 provinces in China (n = 42,751; age = 20–74 years), the highest prevalence rates of overweight and obesity were in Beijing (34.8% and 5.1%, respectively) in males and in Shandong (34.6% and 9.4%, respectively) in females.

The trend of higher calorie and fat diets, reduced level of physical activity and increased sedentary lifestyle are puting more and more Chinese people at risk of becoming overweight at an alarming level (Wu 2006). Chronic diseases account for an estimated 80% of deaths and 70% of disability-adjusted life-years lost in China (Wang et al. 2005). The first comprehensive survey of nutrition and health in China in 2002 (n = 243,479) with data collected from 71,971 households from 132 counties of 31 provinces, autonomous regions, and the municipalities by using the Central Government household census was conducted between August and December 2002. It reported that the nation has 160 million high blood pressure patients; the adult diabetes rate stands at 2.6%, and the number of diabetes patients is estimated to be over 20 million nationwide (The State Council Information Office 2004). It is estimated that by 2025, the number of Asians with diabetes could hit 198 million (Guardian Unlimited 2006).

Unlike the Western developed or developing economies, the situation in Asia is rather complex. First, the economies of countries and regions in Asia are at different phases of development; some like Vietnam and Indonesia are in the early stages of development while others like Japan, Singapore, Malaysia, and Hong Kong are at more advanced stages. Data from several Asian countries show that there is the double burden of under- and over-nutrition, both exerting considerable pressure on the health system (Doak et al. 2005; Popkin 2001b). Other observations show that the prevalence of overweight and obesity increases from childhood into adulthood, is generally higher in urban than in rural areas, and is also higher in higher socioeconomic groups (Florentino 2002; Vijayalakshmi et al. 2002; Wang 2001).

Research on the role of genetic factors

Heredity and genetic predisposition contribute significantly to the development of obesity; this was demonstrated by a familial prevalence of obesity, which occurs in certain families in several generations of siblings. Children of obese parents are more predisposed to the development of obesity than children of normal weight parents and this risk is proportionately higher in older and fatter children (Whitaker et al. 1997). However, genetic factors have not been generally considered as a decisive cause of the recent increase in obesity prevalence. The report from the Centers for Disease Control (CDC) stated, "Clearly, genes related to obesity are not responsible for the epidemic of obesity because the US gene pool did not change significantly between 1991 and 1999" (USDHHS 2002). In a review of twin, adoption and family studies, Bouchard (1996) reported that BMI inheritance accounts for 25–40% of the interindividual variability. This compared with the views of Allison et al. (1996) where about 70% of the inheritance of BMI (controlling for age, sex, and interactive effects) among monozygotic twins reared apart is attributed to genetic variation (Rankinen et al. 2006; O'Rahilly et al. 2003).

Genetic factors play a role in energy balance and turnover in various tissues (e.g. muscles), in dietary preferences and aversions, and food choice. Physical activity is genetically predisposed as shown by the examples of twin studies: monozygotic twins resemble each other more over a certain period of time in total volume of physical activity and movement than do dizygotic twins (Ledovskaya 1972). Greater similarity concerning the structure of movement during certain motor tasks and sports was found in monozygotic twins than in dizygotic twins (Sklad 1972). The genesis of obesity is assumed to be multifactorial, though a strong genetic influence is implicated. Monogenetic types of obesity have mostly been studied in laboratory rodents; and the reasons for obesity development are simple mutations in always one gene. These experiments helped researchers to understand the biologic mechanisms that determine food intake and regulations of body weight (O'Rahilly et al. 2003).

The discovery of the ob gene and coding leptin helped in the understanding of the causes of human obesity.

In recent years, it was possible to identify six genes, the mutations of which are the cause of monogenic forms of human obesity. The products of these genes are leptin and leptin receptors, pro-opiomelanocortin (POMC), receptor for melanocortin 4 (MC4R), and the enzyme pro-hormone convertase 1 (PCSK1). These proteins are the components of a complicated regulation net, in the center of which is the hypothalamus, which ensures an optimal food intake. Oligogenic and polygenic forms of obesity are more difficult to study in humans as the effects of further interfering factors during the human lifespan complicate the analysis (Rankinen et al. 2006; O'Rahilly et al. 2003).

The interaction of genes, the environment, and lifestyle was demonstrated in Pima Indians, who are genetically predisposed to obesity; the Pima Indians who live in the US were 25 kg heavier than the Pima Indians living in Mexico (Prateley 1998). Similarly, the average BMI in Nigerian women and men living in their country is 22.6 and 21.7, while the BMI of Nigerian women and men living in the US is 30.8 and 27.1, respectively (Luke et al. 2002).

The Chinese National Twin Registry, established as a resource for genetic epidemiologic studies of common and complex diseases in twins, gave an insight into understanding the genetic contributions to cardiovascular diseases and cancer. A total of 4500 twin pairs were registered and 700 studies were conducted and followed up longitudinally to better understand the role of genes in the various metabolic disorders brought about by obesity (Yang et al. 2002). In essence, BMI, along with insulin sensitivity and blood pressure were associated with G-protein beta3 subunit (GNB[3]) gene C825T polymorphism (Chen et al. 2003). Indices of obesity were associated with two apolipoprotein A-I gene MspI polymorphisms in selected healthy Chinese subjects, and in patients with early onset type 2 diabetes (Ma et al. 2002b).

Changes in diet and physical activity patterns in Asian countries

The increased prevalence of obesity is mainly due to unbalanced energy equilibrium. According to WHO, the average energy intake in 1963 was 9660 kJ day^{-1}, which had increased to 10,250 kJ day^{-1} in 1971 and to 11,420 kJ day^{-1} in 1992. The forecast for 2010 is 12,200 kJ day^{-1}. However, this forecast is not compensated for by an equivalent projection of increased energy output (WHO 1998).

Rapid economic development in Asia together with raised standards of living over the last three decades have resulted in increased nutrient availability in many countries in the region and also improved health facilities. There have also been marked changes in the sources of nutrients and the patterns and composition of diets (Du et al. 2001a; World Cancer Research Fund 1997; Gopalan 1996). Diets consumed show an increased percentage of energy from fat and simple sugars. In particular, the consumption of saturated animal fat (e.g. meat and fried foods) has also increased markedly in some countries in the region. These observations are supported by the data that show a significant relationship between the economic level characterized by Gross National Product (GNP) and composition of the diet consumed by the population (Popkin 2006; Popkin & Gordon-Larsen 2004).

In China, the average energy density of food has increased over 10 years, from 9.45 kJ g^{-1} in the urban population and 9.16 kJ g^{-1} in the rural population to 10.16 kJ g^{-1}. Fast food and sweetened or carbonated drink consumption have increased manifold in China and such dietary trends are considered to be one of the most important causes of the increased obesity prevalence (Cheng 2003a). In 2002, daily consumption of oils/fats among Chinese urban residents (n = 68,962) was 44 g, up from 37 g in 1992. The energy contribution from fat reached 35%, which exceeded the recommended upper limit of 30% by the World Health Organization (The State Council Information Office 2004; Du et al. 2002). In some Third World countries, the consumption of plant oil was found to be associated with an increase in obesity prevalence (WHO 2002, 2000).

The link between high fat diets and obesity is supported by a number of studies. In comparison to other macronutrients, fat is very energy-dense, containing 38 kJ g^{-1} compared to 17 kJ g^{-1} for carbohydrates and proteins and 29 kJ g^{-1} for alcohol. Thus, diets that are high in fat may lead to passive and unintentional

over-consumption of energy, since appetite is regulated by bulk rather than by energy density (Prentice & Jebb 2004, 2003; Prentice 1998). Fat over-consumption does not necessarily stimulate fat oxidation and a long-term positive fat balance may cause obesity (Swinburn & Ravussin 1993).

Some evidence suggests that physical inactivity rather than high fat diets are a major determinant of obesity. For instance, in recent years, fat intake in the US, parts of Western Europe (e.g. Czech Republic) and the UK have declined by as much as 500 kJ day^{-1} with an increased prevalence of obesity (Rennie & Jebb 2005; Hainer et al. 2004; Willett 1998). Prentice and Jebb (2003) estimate that the average per capita energy intake has declined in the UK since 1970, based on National Food Survey data that were adjusted for meals eaten outside the home, and consumption of soft drinks, alcohol, and confectionery. Despite this decline, the obesity rate in the UK doubled between 1980 and 1991, which led to the conclusion that physical inactivity or a lack of energy expenditure was the cause of obesity rather than an increased energy intake over time. Investigating the causes of physical inactivity over time, Prentice & Jebb (2004, 2003) and Ma et al. (2002a) examined data on television viewing and car ownership from the Central Statistical Office in the UK. They reported that these proxy indicators of physical inactivity (i.e. time spent watching television and/or riding in a car) were more closely related to the prevalence of obesity in the UK than energy intake or fat intake. The existing data from studies in the US and Australia also suggest that TV viewing is likely to be a significant proxy contributing to the obesity epidemic in these countries (Salmon et al. 2000; Jeffery & French 1998).

Indicators of physical inactivity include the hours spent watching television and time engaged in playing videogames. Such sedentary leisure-time pursuits have multiplied throughout the world (Parizkova & Hills 2005; Ma et al. 2002a; Parizkova et al. 2002; Parizkova & Hills 2001). These rapid developments are especially of concern to emerging economies in Asia, whose populations are hungry to enjoy the fruits of economic progress. In China, where economic progress remains unparalleled, observations confirm that the time spent watching television is directly related to an increase in obesity, and that television viewing time is an important predictor of pediatric obesity (Ma et al. 2002a). However, the time for physical activity and exercise during remaining leisure time has not been followed yet. There is a possibility that subjects who spend a lot of time on TV and videogames participate or do not participate in more intense physical activity, and thus can or cannot compensate for sedentarism. This might also explain certain differences in conclusions concerning the effect of TV and videogames, etc.

Reduced physical activity as one of the main causes of a positive energy balance was not only reported in normal weight population but also in obese patients. A reduction in physical labor during work because of mechanization and a reduction in leisure pursuits involving physical exertion are also evident in China, even in the rural regions (Bell et al. 2002). A study conducted by Fu & Fung (2004) reported that 80% of Chinese subjects ($n = 2196$; 39.0 ± 10.7 years) who lived in Beijing, Shanghai, and Hong Kong were sedentary (participating < 90 min $week^{-1}$ in leisure physical activity). Reduced physical activity is a strong predictor of weight gain in Chinese adults. Motorized transportation also contributed to increased obesity; a multistage random-cluster sampling process concerning household vehicle ownership showed that the odds of being obese were 80% higher for owners of motorized vehicles than those who did not own motorized vehicles (Prentice & Jebb 2004; Bell et al. 2002).

It should be noted that some studies on young people in Asia show no meaningful relationship between sedentary activity (e.g. weekly hours of computer use), self-reported physical activity, and physical fitness among normal weight children and adolescents aged between 10 and 15 years (Chia et al. 2002). The researchers studied 240 schoolchildren and adolescents in Singapore and reported an increase in time spent on the computer with age (from a median of 4.9 to 6.0 hours) and a concomitant decline in physical activity as measured by heart-rate monitoring between 10- and 15-year-olds, but indicators of physical fitness (combination of health and skill-related fitness) improved with age. One plausible explanation could be that time spent on the computer has not yet had an impact on physical fitness. A recent study in young people showed that it is the total basket of sedentary pursuits (e.g. reading, sitting, talking on the phone, sleeping) and

not merely television viewing or computer use that is responsible for juvenile obesity (Jago et al. 2005). Hence, reducing the time young people spend in all sedentary behavior, coupled with attractive physical activity alternatives, might make young people more physically active.

Building environments in large, urban agglomerations that reward and encourage masses of people to make lifestyle choices, which have developed more recently in Asia and Latin America, may be a key factor of the current problem. For instance, in developing economic societies, there is abundant energy consumption with very little need for energy expenditure, and this promotes positive energy balance and weight gain (Booth et al. 2001; French et al. 2001; Jeffery 2001). Though there is little concrete scientific evidence that documents the relative risk of various environmental influences that contribute to obesity in the population, the following are noteworthy.

According to Peters (2002), the combination of food environment and physical activity environment is one of the most important contributing factors. Food environment factors that contribute to increased energy intake include large portion sizes, meals that are high in fat, high in sugar and energy-dense, and foods that have a high glycemic index. In addition, the ready availability of soft drinks, fast food value meal combinations, easy accessibility to food all day and night, relatively low cost of food, great variety of foods available, high tasting foods, food deliveries to home and office, and food advertising, all characterize westernization of food habits and eating behavior and their deteriorating effect on populations in other parts of the world.

The physical activity environment factors that contribute to reduced energy expenditure include the declining need and availability for physical activity in the home, school, and workplace due to automation and computerization; efficient and sedentary transport; reduced or no requirement for physical education in schools; reduction in free play before, during, and after school, along with the lack of grounds, gyms, parks, stadiums, and the like; physical activity- and play-restrictive community design; drive-through conveniences; elevators and escalators; inaccessible and inconvenient staircases and poorly ventilated stairwells; television, cyber gaming, the Internet, and other sedentary forms of leisure; and remote controls and labor-saving household appliances (Dietz 1996).

Social and economic conditions influence, mostly through nutrition and physical activity regimens, the prevalence of obesity in different ways. Sociodemographic, behavioral, and reproductive factors are assumed to be associated with an unconscious weight gain in Chinese women, where lower educational level, earlier menarche, and having children early in life are associated with long-term weight gain. Nonetheless, these earlier findings need to be verified by future research (Wen et al. 2003). Among the newly industrialized countries, those with lower incomes and lower education levels are more susceptible to obesity than those who belong to the higher socioeconomic classes, especially in urban populations (Kelishadi et al. 2003). The latter are also more physically active due to a greater participation in sports (WHO 2000). In summary, according to Crawford & Ball (2002), while environmental changes may be necessary to reverse the obesity epidemic, it is critical that any efforts to bring about change focus on those exposures that influence important obesity risk behaviors.

Food diaries lasting 3–7 days are a common method of estimating habitual daily food intake. Personal interviews about food consumption followed by diet analysis using computer programs are also popular methods used to assess food intake of a particular sample in the population. These data provide information about the amount of energy consumed and the composition of the diet (macronutrients: protein, fat, carbohydrate; micronutrients: vitamins, minerals). The patterns of food intake—how many meals per day, largest meal of the day, food aversions and preferences—are disclosed in these methods, which provide valuable information for ascertaining the causes of obesity and also plausible remedial approaches to fat reduction.

Not all obese people have an increased food intake. Overeating can be both absolute and relative in relation to output. Often, there are deficiencies and imbalances with regard to the recommended dietary allowances (RDAs) and relative composition of the ingested food. In China and the developed and developing countries in East Asia, rapid changes in dietary habits such as the easy availability of high energy-dense foods and fast foods are a cause for worry as these changes contribute definitively to obesity in the young and in adults (Kelishadi

et al. 2004; Popkin & Du 2003; Ismail et al. 2002; Stookey 2001; Holmboe-Ottesen 2000). For instance, other studies that show increased meat consumption among multiethnic Hawaiian women were positively associated with BMI, even after adjustment for daily energy intake (Maskarinec et al. 2000).

Fat intake expressed in g capita^{-1} day^{-1} in East and South-East Asia and China has increased substantially, having doubled or tripled over time. The major source of energy is vegetable oil, but the intake of animal fat has also increased from 8–9% of total calories in the early 1960s to 24–30% in the late 1970s (Du et al. 2002; Popkin et al. 2001). The quality of fat (animal or vegetable) is more important for heart health than the quantity of fat (Khor 2004). Other studies on Chinese adults show that high intakes of energy and carbohydrates in both genders, higher intakes of protein and fat among men, and lower levels of occupational and commuting physical activity, not smoking, and being of a higher socioeconomic status are related to higher prevalence of overweight and obesity (Hu et al. 2002). Apparently, at present, people in China pay more attention to other aspects of food rather than food as sustenance, and this could account for the increased prevalence of hypokinetic diseases (Ai et al. 2004). Increased intake of simple sugars in carbonated beverages and snacks between meals has also been considered to be contributors to obesity development (Lobstein et al. 2004; James 2002).

Most frequent health complications of obesity

Increased values of BMI increase the risk of the development of many diseases. In the obese, hormonal characteristics are altered due to deteriorated metabolic status. Increased insulinemia, accompanied by impaired insulin sensitivity and impaired glucose tolerance, increased levels of leptin and altered steroid hormones are reported in the obese compared to normal weight controls. Biochemical parameters of hyperlipidemia—increased level of total cholesterol (TC), triacylglycerol (TG) and low-density lipoprotein cholesterol (LDL-C), and low high-density lipoprotein cholesterol (HDL-C)—are also usually found in the obese (Kim et al. 2005; Zhai et al. 2004; Ko et al. 2001b; Lee et al. 2000). Additionally, uricemia and homocystinemia can also be increased, and total antioxidant capacity can be reduced (Huang et al. 2005).

Insulin resistance, glucose intolerance, and the development of type 2 diabetes mellitus are some of the most serious health complications of obesity (Ko et al. 2001a). Large prospective studies in the US between 1994 and 1995 showed that the risk of contracting these diseases is increased 10 times in women and 5 times in men who are obese. When BMI is 35, the risk of diabetes is increased more than 90 times. In contrast, on the basis of research data, it is estimated that with the abolition of obesity, the prevalence of diabetes can be reduced by 77% in women and by 64% in men. Cardiovascular risks are manifested significantly more in obese subjects (Fu & Fung 2004). High BMI increases cardiovascular mortality (ischemic heart disease [ICHS]) by 2.2–2.3 times in females, and 1.7 times in men; the participation of overweight in ICHS mortality is 25–28% in females and 20% in men (Hainer et al. 2004).

Further health complications of obesity include respiratory, gastrointestinal and hepatobiliary, gynecologic, oncologic, orthopedic, skin, and psychosocial complications. There are also surgical and anesthesiologic risks, and iatrogenic damages (due to inadequate diets, pharmacotherapy). Edema, deteriorated healing of wounds, accidents, and hernias are also implicated in the obese (Jia et al. 2002).

The results of a study by He et al. (2001) showed that the Hong Kong Chinese population has a higher percent body fat (BF) for a given BMI, which would partly explain why the health risks associated with obesity occur at a lower BMI. An analysis of the relationship between BMI and the risk factors of chronic diseases confirm the positive relationship of dyslipidemia, hypertension, and diabetes to overweight and obesity in Chinese adults with BMI > 24.0 kg m^{-2} (Zhai et al. 2004; Fu et al. 2003b), cardiovascular diseases (He et al. 2004; Zhou et al. 2002b), metabolic syndrome (Jia et al. 2003, 2002), and mortality (Gu et al. 2006; Li et al. 2002; Zhao et al. 2002). Obesity is a risk factor for diabetes and dyslipidemia especially in males at a higher age (Ko 2001b & d). Comparative studies of cardiovascular health in residents of Beijing, Shanghai, and Hong Kong showed that Hong Kong residents were in better cardiovascular health than residents of Beijing or Shanghai (Fu & Fung

2004). Sleep-related disorders, disordered breathing (Ip et al. 2001), and depressive symptoms among the obese are also reported to be more frequent than in normal weight Chinese (Li et al. 2004).

The consequences of obesity in relation to physical, mental, psychologic, and social characteristics are well documented. The negative consequences of obesity are related to the degree and duration of obesity; usually, the situation is worse in females and in those who were obese as children and adolescents.

The economic cost of obesity in terms of health care costs is estimated at 2–8% of the gross domestic product. Substantially higher indirect economic costs of obesity relate to costs connected with the illnesses, morbidity, and invalidity related to obesity. Indeed, the morbidity of the obese is two-fold, and the invalidity is two times more frequent in obese women compared to normal weight subjects (WHO 2000; Chen 1997).

Current trends in the prevalence of obesity across Asian countries

According to the IOTF, the prevalence of obesity in the industrially developed countries of North America and Western Europe ranges from 10% to 40% (Cole et al. 2000). Epidemiologic studies show that the highest prevalence of obesity is in Central Europe (Germany, Czech Republic), and the US. The prevalence in the UK, and more particularly in the Scandinavian countries, is lower. Nonetheless, the greatest increase in the prevalence of obesity is found in the urban population of West Samoa where both diet and physical activity have changed significantly in recent times. Obesity is reported in 41.5% of men and 59.2% of women in West Samoa (Hainer et al. 2004).

The effect of adopting the lifestyles of developed Western countries is demonstrated in the former East Germany where obesity increased dramatically after political changes resulted in dramatic changes in lifestyle habits, especially in children and adolescents (Lauderdale & Rathouz 2002). These observations are also supported by observations elsewhere. For example, Asian Americans show lower proportions of overweight at present, but they imply also that the proportion will increase as more US-born Asian Americans assimilate into the lifestyles of the host country (Hainer et al. 2004).

A Western-type lifestyle and diet also explain the increase in coronary heart diseases and mortality in Beijing between 1984 and 1999. Obesity, along with increased smoking and reduced physical activity, is contributing to other hypokinetic diseases like hyperlipoproteinemia, hypertension, insulin resistance, and diabetes (Critchley et al. 2004; Jia et al. 2002).

In countries like China and Japan where overall obesity rates were previously low, obesity appears to be creeping up among the urban populations and is positively related to increased affluence among the population. The differences in energy and nutrient intakes and eating habits of rural and urban populations were found in adult Yi people in the Lingshan autonomous region as a result of differences in household income (Zhou et al. 2003).

The pathologies that are associated with increased obesity are a considerable burden to the economies of these countries due to the increased costs of health care and treatment (Hainer et al. 2004; Wolf & Colditz 1998). The challenges in Asia are compounded by a nutrition paradox demonstrated with the simultaneous existence of both overweight and underweight subjects in Asian countries (Rashidi et al. 2005; Ke & Da 2001), even in one family (the dual burden household) (Doak et al. 2006, 2002). An example of an Asian country with the under- and over-nutrition paradox is the Philippines. Results from a National Nutrition Survey in the country in 1998 showed that the prevalence of underweight (wt/age NCHS Standards) preschool and school children was > 30%, while the prevalence of overweight in the same group was < 1%. Among adolescents, the prevalence of under-nutrition was 19.8%, while prevalence of overweight was 2.9%, and among adults, the prevalence of underweight was 13.2%, while the prevalence of overweight was 20.2% (Villavieja et al. 2001a & b).

Current methods of evaluation and treatment

Evaluation of obesity

The degree of obesity is most often evaluated using the BMI (kg m^{-2}). In adults, a BMI value of 25 is the

cut-off value most used, especially in the West. Values of 25–30 characterize an overweight individual, while 30–35 classifies the 1st degree, 35–40 the 2nd degree, and 40–45 the 3rd degree of obesity (WHO 2000). BMI values > 40 are considered morbid obesity.

BMI as a criterion of overweight and obesity were therefore discussed and established. They have been verified to be a rational reference for Chinese children by the Working Group for Obesity in China (WGOC) on the basis of the 2002 China National Nutrition and Health Survey. Lower screening cut-off points—83rd or 80th—should not be excluded when they are as overweight criteria for prevention and intervention follow-ups (Ma et al. 2005). Reference values of BMI for overweight and obesity evaluation were suggested (Ji et al. 2004).

However, the use of these BMI cut-offs might not be appropriate to classify obesity among Asian populations. Studies have found that Asians in general, although not consisting of a homogeneous population, have a higher percent body fat at a given BMI than Caucasians, and the relationship between BF percentage and BMI is ethnic- and population-specific (Mirmiran et al. 2004, Deurenberg et al. 2003; Fu et al. 2003b; Misra 2003; Li et al. 2002), and this can be partly explained by differences in body build, i.e. differences in trunk-to-leg ratio and differences in slenderness (Yoo et al. 2006; Deurenberg et al. 2002). A re-evaluation of WHO BMI cut-off values is needed particularly for Asians based on a number of studies and lower BMI cut-offs are suggested as criteria for overweight and obesity classifications (Deurenberg-Yap & Deurenberg 2003; Cheng 2003b; Misra 2003; Lee et al. 2002; Deurenberg-Yap et al. 2001; IOTF 2000). The IOTF-recommended BMI cut-off values had low sensitivity and might underestimate the prevalence of childhood obesity in China.

Zhou and The Group of China Obesity Task Force (2002a) established reference norms, viz. 24 and 28 BMI for overweight and obesity, respectively. The sensitivity and specificity of these BMI values made possible the comparison of the prevalence of obesity in different age categories in Beijing, Henan, and Sichuan (Zhang et al. 2003). The prevalence of obesity in Hong Kong Chinese adults was also provided by BMI data (Ko et al. 2001a & b). The overweight incidence, based on BMI, increased between 1984 and 1999 in the urban male population and both males and females in the rural population. However, the increase in BMI was more rapid in the rural than in the urban population (Wang et al. 2003).

The Third China National Nutrition Survey conducted in 1992 presented data on 44,485 adults aged 20–60 years. Results for BMI showed a logarithmic normal distribution. The average values of BMI was 22.1 ± 3.1. The 50th, 85th, and 95th percentiles of BMI were 21.6, 24.9, and 27.4 kg m^{-2}, respectively. The 85th percentile of BMI was closer to the BMI cut-off points for overweight recommended by WHO, but the 95th percentile was lower than WHO's cut-off points for obesity. The distribution of BMI based on age and gender was significantly different between the rural and urban areas (Du et al. 2001b). A comparison of BMI in children from China, Russia, and the US using IOTF criteria showed that the weight categorizations for BMI produces similar estimates of overall overweight prevalence but different estimates for obesity prevalence (Wang & Wang 2002).

In defining obesity in the Chinese population of Hong Kong, lower cut-off values are established as the definition is based on BF assessments using bioelectrical impedance (BIA). Despite similar BF content, the BMI cut-off values used to define obesity in Hong Kong people are lower compared to Caucasians, i.e. a BMI of 23 is used to classify overweight individuals, and a BMI of 26 kg m^{-2} is used to classify obesity in Hong Kong Chinese people (Ko et al. 2001c & d). Percent BF (%BF) that was assessed using DEXA did not correspond to the predicted %BF derived from BMI using a prediction formula developed in Caucasian populations. The formula under-predicted %BF by 1.1% in male and 3.4% in female subjects, respectively. A predicted BMI of 25 and 30 kg m^{-2} using a Caucasian-based formula corresponded to an actual BMI of 23 and 25 kg m^{-2}, respectively. Data from linear regression analysis showed that 25% BF corresponded to a BMI of 24.6 kg m^{-2} and a waist circumference of 86 cm in males; 35% BF corresponded to a BMI of 22.6 kg m^{-2} and a waist circumference of 73.5 cm in females (He et al. 2001). These results support the recommendations of using lower BMI cut-offs for Asians instead of those recommended by the IOTF to define obesity in Asian countries. Additionally, a study in Chinese adolescents showed that the IOTF cut-off points have low sensitivity and

high specificity, which might be suitable for identifying obesity, but not for the purpose of screening (Zhang et al. 2004). BMI is significantly related to %BF in Chinese adolescents living in urban Beijing (Zhang 1994). Methods for body composition and fatness measurements have to be validated in different populations as they do not give comparable results (Deurenberg & Deurenberg-Yap 2003).

Treatment of obesity

Reduction of food intake is the most common approach to reduce excess body fat. The consumption of energy-dense foods like fat and sugar are reduced, the consumption of high-nutrient density foods like vegetables and fruit is increased, along with preservation of RDAs of vitamins and minerals. In treating morbid cases of obesity, a very low calorie diet (VLCD) is used. However, this approach requires inpatient hospital treatment, as under the conditions of a very low energy intake, it is necessary to monitor possible health complications. Low glycemic index diets have been used with some success. Marked reduction of food intake is not recommended in the treatment of childhood obesity as it slows down growth in height and development of lean body mass (Parizkova & Hills 2005, 2001).

The use of physical activity or exercise therapies is more suitable for growing young, obese subjects than for obese adult subjects due to pre-existing conditions brought on by obesity. Body weight supported exercise conditions such as in an aquatic milieu, then in lying, sitting, squatting positions is possible especially in the initial periods of the weight reduction treatment. These exercise therapies of an adequate character result mostly in a generally improved physical condition and fitness, which is the condition for fat reduction (Parizkova & Hills 2005, 2001). A combined therapy—diet, increased physical activity, and exercise (Chen 1997)—of special intensity, character of longer duration and increased frequency, and behavioral and psychologic treatment are most often recommended (Council on Sports Medicine and Fitness 2006; Doak et al. 2006). However, such a patient-centered regimen must be based upon a proper medical, physiologic, nutritional, hormonal, biochemical, and psychologic assessment of the patient.

The metabolism of the adipose tissue is controlled by adrenergic hormones, which stimulate lipolysis and the oxidation of fatty acids, and also by insulin, which reduces lipolysis and stimulates the deposition of TG in adipocytes. During muscular work, catecholamines are released in greater quantities and enhance lipolysis; trained subjects are better able to utilize lipid metabolites from the adipose tissue, provided enough oxygen is available under conditions of an increased aerobic power. Adequate levels of aerobic power characterized by increased maximal oxygen uptake make it possible to utilize lipid metabolites during exercise as an energy source. However, this capability is lower in the obese, hence there is a reduced capacity for utilizing excess fat in the body (Parizkova & Hills 2005, 2001; Hainer et al. 2004).

Cognitive behavioral, pharmacologic, and surgical interventions

Psychotherapy is the professional application of psychologic principles on patients so as to change their behavior, thinking, emotions, or personal characteristics in a desirable way. These principles are applied to obese subjects to help them decrease excess body weight and fatness. Such therapies have been used successfully to manage addictions like smoking and drug abuse. The use of psychotherapy should extend to both managing food intake and also to exercise adherence and the approaches should be individually prescribed on the basis of case history (degree and duration of obesity and pre-existing conditions) and also personal psychologic characteristics (Hainer et al. 2004).

Pharmacotherapy is also used in the treatment of adult obesity, especially in cases of severe obesity. The medications used target either food intake or energy expenditure. Those which reduce food intake are sibutramine, fentermin (Adipex retard), efedrin, and caffeine. Those which increase energy expenditure are sibutramine and also the mixture of efedrin and coffein. A medication that reduces the availability of fats in the intestines is orlistat (Xenical). Other pharmaceuticals are dexfenfluramine, fenfluramine, and agonists β3-adrenergic receptors which also interfere with lipid metabolism. They not only influence the metabolism of the adipose tissue but also have an effect in other tissues (Hainer et al. 2004). Some studies showed that short-term treatment with orlistat without the use of a hypocaloric diet insignificantly improves cardiovascular

risk profiles and insulin sensitivity in severely obese subjects (Tong et al. 2002). Obese Chinese subjects in a Da-Quing study showed that lifestyle changes or pharmacologic intervention can prevent type 2 diabetes (Scheen et al. 2003). Metformin, combined with lifestyle intervention, can affect the prevalence of metabolic syndrome in obese children and adolescents (Fu et al. 2006).

Surgical interventions are also used in cases of morbid obesity when BMI is higher than 40, and especially when other sorts of reduction treatment fail. Often, gastric banding is used, which is mostly executed laparoscopically. This method causes the feeling of food satiety to occur earlier. Gastric bypass and biliopancreatic diversion are some other approaches to the reduction of food intake. These interventions usually have good results; however, vomiting and gastric pseudo-obstruction can occur, especially when patients do not follow the instruction on reduced food intake. Gastric stimulation is beginning to be used as the least invasive approach, but the experiences are still limited.

Summary

Obesity is the most pervasive metabolic disease in industrialized and developed countries and increasingly in the developing world. Obesity is represented in all age categories and in male and female populations. In adults, it is mostly accompanied by various health problems—diabetes, diseases of the cardiovascular system, dislipidemia, ischemic heart disease, hypertension, cholecystopathy, orthopedic problems, and limited motor ability, etc.; and morbidity and mortality are shown to be increased due to obesity. The health situation is worse when obesity starts in childhood. Rapidly changing life conditions including the easy availability of energy-dense diets (increasing fat and sugar intake), coupled with reduced physical activity resulting mostly from the transfer of a Western lifestyle are considered to be the most important factors in the development of obesity. Genetic factors play a decisive role in a minority of cases, and in most cases only because of an inborn predisposition. Deteriorating health, social and economic consequences of obesity were discussed. Managing obesity includes a number of assessments and evaluations—morphologic, functional, dietary, hormonal, biochemical, and psychologic. These make possible a more holistic evaluation of the causes and status of the obese. Such data allow for more efficient and effective treatment—by reducing and monitoring dietary intake—in morbid cases a very low calorie diet (VLCD). Exercise alone as a remedy may be difficult to apply in more advanced cases of obesity and decreased fitness and may not be an effective treatment because of low levels of functional capacity and fitness, and accompanying comorbidities among the obese, and can be used only after some reduction in body weight. We recommend timely diagnosis of early stages of obesity using reliable methods and efficient multifaceted treatment approaches combining intervention with nutritional and physical activity regimens, along with behavioral and psychologic intervention.

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