

Obesity in Children and Adolescents: Working Group Report of the Second World Congress of Pediatric Gastroenterology, Hepatology, and Nutrition

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Main Topics	<i>Assessment of Obesity and Related Comorbidities</i>	<i>Prevention Strategies</i>	<i>Treatment Approaches</i>
Research	Explore the genetic background of obesity and the influence of metabolic programming	Identify targets for prevention (metabolic, behavioral and environmental)	Investigate the efficacy of nutritional, pharmacological, and surgical strategies to treat obesity, and their short- and long-term outcomes and safety
Intervention	Develop and validate an internationally applicable clinical classification system of excess weight and treatment standards for obesity-related complications	Promote healthier lifestyles by way of legislation	Create consistent, scientifically supported messages for public education about dietary treatments of obesity and the potential risks of herbal supplements and unhealthy dieting practices
Education	Develop training programs for healthcare professionals in the recognition, assessment, and treatment of the medical and psychological complications of obesity	Promote public age-specific educational programs highlighting the importance of physical activity and healthy diet	Educate healthcare providers and teachers about scientifically-supported treatments for obesity and its complications

SUMMARY OF THE PROBLEM

Obesity is defined as an excess of body fat. It involves both genetic and environmental influences and is associated with >40 different medical and psychological problems. Thus, obesity places an enormous social and economic burden on most societies, making it the most important nutritional disease in developed countries. The continuous variations in height and relative muscle mass show that obesity cannot be evaluated by weight measures alone, particularly in the case of children and adolescents. Body mass index (BMI; weight in kilograms divided by height in meters squared) is a useful measure of adiposity because it accounts for variations in height.

Availability and palatability of food and low levels of physical activity are frequently associated with increas-

ing obesity in most populations. These patterns appear to be transferable from one population to another and affect immigrants as they assimilate into a new culture. However, determining the key elements of the diet or lifestyle that predispose to obesity remains challenging and is an essential focus of research.

Studies of twins and adoptees provide useful estimates of the role of heritable factors in determining an individual's body weight (see Bouchard's 1997 summary of relevant papers on heritability) (1). Adoption studies tend to generate the lowest heritability estimates (30%), whereas twin studies provide the highest heritability estimates (70%). The variability in these estimates of heritability depends in part on definitions of obesity: more severe obesity tends to have a greater heritability factor than less severe obesity.

There is evidence that nutrition during early development may have permanent and long-term effects on the risk of future obesity. This "metabolic program"

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conspires with genetic factors to create a “set point” that affects an individual’s body weight throughout the lifespan. Various factors have been associated with the development of obesity: intrauterine environment, diabetes, maternal smoking, duration of breastfeeding, early feeding practices and complementary food introduction, and weight gain in early childhood and during puberty. Thus, interventions to prevent obesity should target these periods.

Most of the complications typical of adults and older people are now appearing in children and adolescents. Psychosocial dysfunctions, isolation, depression, and low self-esteem are often early consequences of obesity, whereas cardiovascular risk factors and diabetes are usually long-term complications of excess weight.

The management of obesity in children and adolescents must include preventive and treatment programs designed to support healthy diet and physical activity; nutrition education at all levels, in homes, schools, and canteens, must be associated with physical activities aimed at prevention and cure. Currently, drugs are not considered safe and effective for all ages and should be reserved for cases that do not respond to behavioral treatments. Surgery is a last resort option in carefully selected severely obese adolescents, especially those with severe metabolic disturbances.

Prevention is the best way to combat obesity. Government, industries, and local networks could contribute to preventive measures, eg, providing physical activities, preventing the consumption of unhealthy meals in schools, and continuing education programs for health-care and related professionals.

ASSESSMENT OF OBESITY

Clinical Anthropometry and Classification of Excess Weight

Develop and Validate a Universal Clinical Classification System for Excess Weight and Treatment Standards for Obesity-Related Complications

BMI is a practical and useful measure of adiposity because it accounts for variations in height. By convention, obesity is defined as a BMI of ≥ 30 in adults. There is a strong but imperfect correlation between BMI and body fat. For children and adolescents, adiposity varies by age and gender; thus, BMI percentiles are the appropriate standard. In the United States, “overweight” is defined as a BMI over the 95th percentile for age. The US Centers for Disease Control recently developed new reference charts. In an effort to describe a healthy population and to track trends in obesity over time, the BMI for age reference charts was prepared from national surveys; for some age groups recent weight data were not

considered because of rapid increases in obesity in this population during the past decade.

The International Obesity Task Force (IOTF) has developed a definition of overweight and obesity for children and adolescents based on nationally representative growth studies from six countries (Great Britain, Brazil, the Netherlands, Hong Kong, Singapore, and the United States). The cut points for obesity and overweight were based on the BMI for age centile curves that, at 18 years of age, pass through the widely used adult cut points of 25 and 30 kg/m², respectively. These age- and sex-specific BMI cut points developed by Cole et al (2) are very useful for epidemiological research because they are applicable to an international population and can be used to compare populations worldwide. However, as the authors acknowledge, the reference data set may not be representative of non-Western populations. BMI measurements are useful for epidemiological studies and are clinically practical estimates of obesity. However, BMI can overestimate or underestimate body fat considerably because of variations in lean body mass between individuals and between ethnic groups. Direct measures of body fat may be necessary for physiological studies and require the use of specialized calipers or expensive procedures such as dual energy x-ray absorptiometry, magnetic resonance imaging, or plethysmography.

There is a need to accomplish the following:

1. Develop guidelines and classifications of obesity and overweight for children and adolescents, as well as anthropometric references and approaches that can be used in epidemiological studies worldwide.
2. Study the validity of using the IOTF BMI standards to make international comparisons and to monitor secular trends in childhood obesity, especially in developing countries where children and adolescents have very different patterns of growth and development compared with their counterparts in industrialized countries.
3. Collect national longitudinal data in developing countries to study the problem of childhood obesity, especially in older children (>5 years of age) and adolescents.

Conduct Studies to Clarify the Prevalence and Incidence of the Complications of Overweight and Obesity in Childhood and Adolescence: Large-scale prospective population studies should incorporate careful anthropometric measurements and regular monitoring of selected obesity-associated complications using some or all of the following tests: fasting blood tests (glucose, insulin, lipids, liver function tests), blood pressure measurement, glucose tolerance test, liver ultrasound, measurements of psychosocial functioning, lung function tests, and biomechanical or podiatric assessment. This approach would reveal the prevalence of obesity-associated complications in the general population and the incidence of new cases. Note that some complica-

tions lend themselves to measurement in population surveys (eg, hypertension and biochemical abnormalities), whereas others may not be identified (eg, obstructive sleep apnea). Agencies to be involved and funding opportunities include IOTF, WHO, non-governmental organizations, and UNICEF.

Coordinated multicenter studies of clinical populations of overweight and obese children and adolescents should incorporate careful anthropometric measurements and regular monitoring of selected obesity-associated complications, ie, fasting blood tests (glucose, insulin, lipids, liver function tests), blood pressure measurement, glucose tolerance test, liver ultrasound, measurements of psychosocial functioning, lung function test, biomechanical or podiatric assessment and sleep studies.

Develop Effective Interventions for the Complications of Overweight and Obesity in Childhood and Adolescence. Coordinated multicenter studies of interventions in clinical populations of overweight and obese children and adolescents must be implemented. Whenever possible, the studies should be randomized controlled trials. The studies should examine the following clinical issues: for glucose intolerance and hyperinsulinemia, insulin-sensitizing agents (eg, metformin) and lifestyle intervention (different aspects, eg, types of exercise, types of dietary interventions, level of intensity, and support given); for NASH, insulin-sensitizing agents, various lifestyle interventions, and antioxidants; and for obstructive sleep apnea, tonsillectomy/adenoidectomy, continuous pressure airway, and weight loss interventions.

Genetics

We must advance our understanding of the physiological and genetic determinants of body weight to establish appropriate treatment for the severely obese. Moreover, understanding the mechanisms underlying the genetic components of more moderate obesity, which seems to be induced by cultural and environmental influences, is likely to allow better targeted efforts to modify these environmental influences. The pediatric research community should play a central role in this field because of its unique access to severely affected individuals and their families.

Association studies use a case-control design to assess the association between variations in genotype and obesity phenotype. This technique lends itself to the testing of several polymorphisms in candidate genes within a population; however, it is prone to substantial false-positive and false-negative results, depending on sample size. Therefore, the results of association studies are useful if similar gene associations can be demonstrated in several different populations. The technique has been used to analyze many candidate genes from the afferent and efferent pathways mentioned above in genetically similar populations (siblings, twins, or kindreds). By

2001, polymorphisms near 58 candidate genes had been shown to have some association with obesity phenotypes (3), eg, ghrelin, peroxisome proliferation-activated receptor-gamma, uncoupling proteins, and the β -3 adrenoceptor genes.

In linkage studies, genome-wide scans of large populations are used to assess the strength of the association between variations in a genomic locus and the phenotype. The list of published linkages to obesity phenotypes is updated yearly (3). Studies of large populations have identified many chromosomal loci that are associated with a variety of obesity-related phenotypes, eg, BMI, leptin levels, fat distribution, and hyperlipidemia. Thirty-three such loci had been identified as of the 2001 gene map update, some of which appear to represent the chromosomal regions of previously identified candidate genes such as the leptin or MC_4 receptors.

A number of human genetic syndromes displaying mendelian patterns of transmission and a phenotype that includes obesity have been identified and catalogued in the Online Mendelian Inheritance in Man (OMIM) database (<http://www3.ncbi.nlm.nih.gov/omim>). Twenty-five of these syndromes have been mapped to one or more chromosomal locations.

Metabolic Programming

There is strong evidence that some “environmental” influences during gestation and early childhood may have permanent effects on the “metabolic program,” thereby determining weight status later in life. Specific predictors are maternal nutrition, diabetes status, and tobacco use during gestation. Studies in animals and humans are necessary to clarify the physiological mechanisms underlying this metabolic programming. Carefully designed intervention studies are required to determine whether modification of some of these factors such as maternal weight status and early childhood feeding patterns will ultimately reduce the risk of obesity in offspring.

Goal

To explore the genetic background of obesity and the influence of metabolic programming.

Plans to Achieve the Goals

Means to improve clinical phenotyping include developing a common dictionary of terms to allow standardized evaluation across multiple centers, supporting the development of common databases, and facilitating participation of the pediatric research community in genetic studies of large populations. This will require careful planning to protect subject confidentiality. Participation in genetic studies will be enhanced by public awareness of the problem of obesity and of the value of understanding the underlying genetic and physiological mechanisms.

Assessment of Clinical and Metabolic Complications of Excess Weight

Obese children and adolescents suffer from comorbidities affecting almost all body systems. The immediate effects include social and psychological problems and significant medical morbidity, whereas the long-term effects include the establishment of risk factors for cardiovascular disease and diabetes mellitus (type 2) and the development of adult obesity.

Short-Term Complications

The most common consequences of obesity in childhood and adolescence are those related to psychosocial dysfunction and social isolation. Preadolescent children associate an overweight body shape with poor social functioning, impaired academic success, and reduced fitness and health, although there is little evidence to suggest that self-esteem is significantly affected in obese young children. However, cross-sectional studies of adolescents show an inverse relationship between weight and both global self-esteem and body esteem. Obesity in adolescent girls is significantly related to body dissatisfaction, a yearning for thinness, and bulimia. Adolescents are very self-conscious about body shape and physical appearance; hence, it is not surprising that the pervasive, negative social messages associated with obesity in many societies have an impact on adolescents.

Overweight in adolescence may also be associated with social and economic problems in the medium term. A large prospective study from the United States has shown that women who are overweight in late adolescence are more likely, in early adulthood, to have lower family incomes, higher poverty rates, and lower marriage rates than women with other forms of chronic physical disability who are not overweight. These findings probably reflect social discrimination against obese persons.

Significant orthopedic complications that occur more commonly in obese children are slipped capital femoral epiphyses and tibia vara. Compared with lean children, obese children are more likely to present with slipped capital femoral epiphyses at an earlier age and to have bilateral involvement.

Hepatic complications of obesity include nonalcoholic hepatic steatosis (NASH), characterized by elevated hepatic transaminase activities and a fatty liver on ultrasound and often associated with insulin resistance and glucose intolerance. Hepatic cirrhosis has been reported as a complication of NASH even in childhood. Obesity is the major cause of gallstones in children without other medical problems. Gastroesophageal reflux and gastric emptying disturbances are other complications of childhood obesity and appear to be a consequence of raised intra-abdominal pressure resulting from increased subcutaneous and visceral fat.

Cross-sectional studies have suggested an association between childhood asthma and overweight, although the cause of this association is not clear. Overweight children with asthma also experience more severe respiratory symptoms than do lean children with asthma, and they require more medications and more frequent hospital treatments. Obstructive sleep apnea may occur in obese children and is usually associated with adenotonsillar hypertrophy and insulin resistance.

Obesity, especially central obesity, in childhood is also associated with risk factors for heart disease and type 2 diabetes. Dyslipidemia is frequently present, with the lipoprotein pattern characterized by raised levels of triglycerides, total cholesterol, and low-density lipoprotein cholesterol and reduced levels of high-density lipoprotein cholesterol. Other features of the metabolic syndrome such as hypertension, hyperinsulinemia, and insulin resistance are also frequent in children with central obesity. The incidence of type 2 diabetes mellitus among children and adolescents is increasing and is inextricably linked to the prevalence of obesity among young people. The early onset and increasing prevalence of this disease could pose a major public health problem as more people develop long-term complications at younger ages.

Long-Term Complications

The most significant long-term consequence of childhood obesity is its persistence into adulthood, with all the consequent health risks. This is more likely if there is a family history of parental obesity, obesity in late childhood or adolescence, and severe obesity. Blood lipid and lipoprotein concentrations, insulin concentrations, and blood pressure are consistent from childhood into young adulthood, with obesity at baseline being a significant predictor of adult values. Overweight in adolescence is also associated with long-term mortality and morbidity, a finding that is independent of adult weight and socioeconomic status. Indeed, several long-term cohort studies have shown relative risk estimates of ≈ 1.5 for all-cause mortality and 2.0 for mortality from coronary heart disease for overweight children and adolescents compared with their leaner peers.

The recent obesity epidemic has been associated with increases in medical complications of obesity for which health care is often not optimal. Treatment of obesity and obesity-associated complications in different healthcare settings (eg, primary care, tertiary care, community settings) will have different implications for healthcare professional training and resource allocation.

Economic Costs of Overweight and Obesity in Childhood and Adolescence

Economic costs can be classified as direct, indirect, or intangible. Direct costs are those related to the use of the healthcare system in the treatment of obesity and its

complications. Indirect costs result from a reduction or cessation of productivity to either the individual or the family as a result of disease or premature death. Intangible costs are related to the social and personal losses associated with obesity.

The increased prevalence of overweight and obesity in childhood and adolescence, together with the earlier onset of obesity-associated complications, suggests that there will be a rise in the use of health services as a result of obesity, as well as a rise in other costs resulting from the burden of this disease. Very little data have been published on the economic costs of obesity in childhood and adolescence. Information about the economic costs of obesity may persuade policy makers to provide resources for interventions to prevent or treat overweight and obesity.

Goal

Develop training programs for healthcare professionals in the recognition, assessment, and treatment of the medical and psychological complications of obesity.

Plans to Achieve this Goal

Delineate Further the Economic Costs of Overweight and Obesity in Childhood and Adolescence.

The following are examples of the types of studies that are required, generally at the national level: hospitalization costs; cost for treatment of overweight and obesity in nonhospital settings; cost for treatment of obesity-associated complications to be ascertained and factored in, for example, treatment of obstructive sleep apnea, type 2 diabetes mellitus, NASH, orthopedic complications, asthma, psychological problems; indirect costs of obesity in childhood and adolescence; intangible costs of obesity in childhood and adolescence, eg, quality of life, school performance, job opportunities, employment prospects; and finally, cost of treatment and prevention interventions.

Develop and Evaluate Training Programs for Healthcare Professionals in the Recognition, Assessment, and Treatment of Obesity-Associated Complications. The approach to health service delivery and health professional training for recognition, assessment, and treatment of obesity-associated complications varies between countries. Hence, the medical education goals will need to be addressed primarily at the national level rather than internationally. These goals will also need to be linked with the medical education goals for the treatment of obesity (ie, not just its complications). Examples of the type of resources or training programs that could be developed or better used are (1) Web-based resources suitable for use by health professionals with regard to families, young people, specific high-risk ethnic groups, special populations; (2) training of health professionals

in group-based programs aimed at parents of children and at adolescents; (3) "train the trainer" programs; (4) programs dealing with the treatment of specific complications such as orthopedic and dermatological problems, sleep disorders, and type 2 diabetes; (5) Web-based and interactive face-to-face teaching modules suitable for the undergraduate level, eg, students of medicine, nursing, physiotherapy, dietetics, and psychology; and (6) Web-based and interactive face-to-face teaching modules suitable for use at the postgraduate level, eg, medical practitioners, nurses, dieticians, physiotherapists, and psychologists.

PREVENTION OF OBESITY

Causes of Obesity

It is not known what social, environmental, behavioural, and biological factors might have contributed to the secular trends in childhood obesity. Moreover, there is a need to identify the predictors of future obesity and of the associated medical problems within populations, including genetics (genotype and/or parental obesity), lifestyle factors (diet and physical activity), and clinical risk factors (insulin resistance, cardiovascular disease, etc.)

General Considerations

Many studies in diverse populations suggest that behavioral techniques are important tools in obesity prevention and management, particularly when parents rather than the child are given the primary responsibility for behavior change. Several trials also suggest that focusing on reducing sedentary behavior can be effective. Reviews of the specific techniques that have been studied for the treatment of pediatric obesity suggest that most treatments have only a modest efficacy (7–10). Unfortunately, many studies of techniques to prevent childhood obesity are characterized by sample size and methodological limitations (9,10).

Activity

A large proportion of the world's population does not take sufficient physical activity to sustain physical and mental health. Urbanization and the increasing use of automobiles have contributed to decreasing physical activity, and less time is spent on structured exercise and on buying and preparing food. Meanwhile, occupational energy expenditure is often diminished. Many of these problems can and should be addressed by careful urban planning and workplace policies that promote and support physical activity.

For children and adolescents, school is the most obvious public program to promote physical activity. School can provide facilities and opportunities for active play and alternatives to sedentary activity. For example, school-based playgrounds and after-school programs are safe alternatives to television and can enhance physical

activity. Cultural and family attitudes also affect physical activity.

Among the programs devised to increase physical activity is the Agita São Paulo in Brazil, which targets a population of >36 million individuals (11). It was launched in 1997 and involves >250 government, non-government, and private institutions. Because of its impact, the program was extended to the entire country (Agita Brasil) and specifically targets children, adolescents, the elderly, and blue- and white-collar workers. Agita also served as a model for public educational programs in other countries.

The concept of healthy schools has been implemented in many regions and entails an integrated program of physical activities and education on nutrition and avoidance of bad habits related to drinking, smoking, and eating snacks in the school environment. The Planet Health(12) program in Boston (Mass) and others (13,14) are examples of such programs in which information, interaction, and dietary approaches are taken to promote healthy lifestyle in a school-based setting.

Diet

In general, dietary trends have moved toward high-density processed foods with or without high fat content. Some of these trends are promoted by the food industry but supported by consumers. Despite cultural differences, market forces have been supporting such a dietary trend worldwide. Conversely, if consumers can be educated or otherwise encouraged to increase their demand for healthy diets, market forces will support a reverse trend. Public education and governmental regulation could encourage the wider use of nonhydrogenated fat spreads, the decreased use of processed foods containing trans fatty acids, and the use of vegetable oil for domestic consumers and ensure an adequate and sustainable supply of fish, fruits, vegetables, and nuts in domestic markets. Careful analysis of the evidence in support of such dietary changes is required to develop a scientific consensus and to avoid sending confusing or conflicting messages to consumers.

Schools and other public food programs can help to promote healthy diets by careful planning and investment in the facilities required to provide fresh fruits and vegetables. Alternative suppliers including small local food producers may enhance such efforts. Limiting students' access to less healthy foods such as those available in vending machines is being considered or enacted in some communities.

Marketing practices commonly displace local/ethnic dietary patterns, and global marketing in particular has wide-ranging effects on both consumer appetite for goods and perceptions of their value. Although some traditional diets could benefit from modification, research has shown that many are particularly "healthy" and clearly environmentally sustainable. A return to tra-

ditional dishes, as is seen France, Chile, and Brazil, could help to prevent obesity.

Physical Activity

No direct relationship has been proved regarding the link between decreased physical activity and obesity in children, but strong circumstantial evidence suggests that sedentarism and lifestyle activity are related to the worldwide epidemic of obesity, particularly in older children and adolescents. Prospective studies are required to determine relationships between specific activity patterns and changes in body weight.

Goal

Identify targets for prevention.

1. Research that identifies the targets for obesity prevention and techniques to promote healthy lifestyle, establishes the efficacy of such interventions, and determines their costs.
2. Establish practical and effective techniques to promote physical activity and decrease sedentary behavior in children and adolescents, particularly through public programs that can be disseminated to large populations.
3. Measure the effectiveness of decreasing the availability of such foods as soft drinks and candy.
4. Assess the role of vending machines and other specific means of providing food in school in promoting obesity.
5. Determine the effectiveness of changing foods available in school cafeterias.

Plans to Achieve These Goals

To be effective and sustainable, a strategy must reflect local and national realities. It must be scientifically sound and based on biological evidence; clinical trials should be done in representative populations, be culturally consistent, and be economically feasible.

Goal

Plans to Achieve These Goals

Plans include support for well-designed intervention studies of the effects of altering specific factors on the long-term risk of obesity in a child: (1) maternal weight control and diabetes control before and during pregnancy; (2) effects of breast feeding, focusing on eliminating confounding influences and elucidating mechanisms (caloric load, milk content versus mode of feeding, role of solid feeds); and (3) modification of specific feeding practices or physical activity patterns in childhood or

adolescence. Another way to achieve this goal is to promote animal studies that may cast light on the physiological mechanisms underlying “metabolic programming” during gestation and infancy.

Most research related to obesity in pediatric populations has been descriptive or focused on dietary, physical activity, or behavioral interventions to treat the condition. Very few studies have truly addressed preventive strategies in a nonobese but at-risk population (4–6). Nonetheless, the findings from descriptive and intervention studies can inform the goals and design of future studies of obesity prevention.

Laws and Regulation

Governmental regulation and legal action to enable such initiatives will vary, depending on the governmental and legal structure of the country and on public opinion. Some authorities are trying to establish regulations and laws to forbid the selling of so-called unhealthy foods in schools; others are considering regulations to limit advertising by the food industry. Recently, the US food industry was the target of legal action against obesity-promoting practices. However, before legal action can be taken, we must establish scientifically determined principles regarding the optimal composition of diet and the efficacy of specific techniques used to promote lifestyle changes.

Many countries favor governmental regulation of food advertisements and control of food sold or served in schools, ie, prohibiting the selling of snacks, soft drinks, and fried items. Strict control is difficult and may encourage “black markets.” Moreover, regulation may fail to control resources such as shops near schools or food brought from home. There is a need for research to establish appropriate and effective means of ensuring lifestyle changes in different cultural economic and regulatory climates. Laws must be supported by specific nutritional advice and by research, not biased by industry or other special interest groups.

To prevent obesity, educational institutions, governments, and industry must have the same goals, and all must be involved in initiatives. Program funding must reflect the resources of the entire community, including private and governmental sectors. Educational programs must be designed to reach a variety of age groups, pregnant women, and diverse cultural populations. Continuing medical education must inform healthcare providers of consistent and scientifically supported data.

Goals

Promote healthier lifestyles by way of legislation.

1. Determine the effectiveness of specific regulatory practices to promote changes in schools or in communities.

2. Seek creative alternatives to legal and regulatory action to promote these changes.

Public Programs

Goals

Promote age-specific educational programs highlighting the importance of physical activity and healthy diet.

Plans to Achieve this Goal

1. Public education to promote physical activity and a healthy diet supported by government, public, and private organizations.
2. Public facilities and programs implemented in ways that are consistent, yet appropriate, to the culture and resources of the local community.
3. Education of healthcare providers and teachers to ensure accurate, consistent communication of scientifically proven information.
4. Disseminate knowledge of techniques shown to be effective in one community to allow consideration of these practices in others.

TREATMENT APPROACHES FOR OBESITY IN CHILDREN AND ADOLESCENTS

Obesity treatment should aim at the long-term stabilization of body weight and body fat content within the normal range, together with a good quality of life, ie, psychosocial and physical well-being, and no or very few adverse effects. Most treatment options focus on changing dietary habits and composition and enhancing physical activity and other behavior changes. The long-term (5 to 10 years) success of current obesity treatment programs is not entirely satisfactory, although it appears to be better in children than in adults. Therefore, new approaches to the treatment of obesity and their applicability to pediatric populations should be explored. There is a need for more data about diet, drugs, and surgery.

Diet

Both the general public and the medical profession widely believe that the obesity epidemic results from an increased intake of high-fat, energy-dense foods and little physical activity. These beliefs are reflected in dietary guidelines, exemplified by the food guide pyramid, that recommend reduced fat and sugar intake and increased consumption of carbohydrates. In children, the use of a balanced, hypocaloric diet is generally recommended for weight loss. This doctrine has been challenged by the suggestion that carbohydrates with a high glycemic index (GI) may contribute to the problem. The

GI is related to the blood glucose response to a particular food compared with white bread or glucose. Rapidly digested and absorbed carbohydrate foods tend to have high GI values. The GI of a meal is also influenced by cooking and processing methods, ripeness, acidity, fat, and protein. The role of the GI in pediatric obesity remains controversial. However, low-GI diets have brought short-term benefits in obese children and adults. Longer-term multicenter and community-based studies have not been performed in children; hence, it is too early for definitive public health recommendations.

Children with severe obesity may also benefit from a stricter hypocaloric, ketogenic diet such as a protein-sparing modified fast (PSMF) diet. Benefits of this diet include relatively rapid weight loss (1 to 2 kg/wk) and reduction of food intake, which is thought to be related to ketosis. Complications can include protein losses, hypokalemia, inadequate calcium intake, cholelithiasis, and orthostatic hypotension. Overall, PSMF regimens seem to be reasonably effective when performed under medical supervision, and they result in more rapid weight loss than conventional dietary and behavioral therapy, at least in the short term. However, there are no data on the long-term outcome in children. In addition, there are no guidelines about the length of dietary restriction or about dietary/behavioral approaches to maintaining weight loss after a PSMF diet. Most adults on such diets quickly regain the weight they lost. Inpatient treatment programs and residential summer camp programs have been effective in the short term, with some effective even in the long term. Although these programs cannot serve as treatment models because the methods used were varied, treatment programs were not fully described, and several had methodological limitations, they may be useful in two ways (1) they are very efficient in the treatment of comorbidities and (2) they are an appropriate controlled setting for the development of a range of treatment models and strategies to tackle the worldwide obesity epidemic.

Drugs

Many of the drugs used to treat obesity in adults have been characterized by unproven claims, highly variable efficacy, and significant side effects. Medication in adults appears to be effective only in conjunction with intensive dietary counseling and behavior modification strategies. In addition, weight regain typically occurs on discontinuation of medication. The US Food and Drug Administration has approved two drugs for obesity treatment in adults, but there are limited data about the effect in children. Sibutramine, an appetite suppressant, acts mainly by inhibiting norepinephrine and serotonin. Weight loss is typically modest (5% to 8%), and weight is generally regained after the drug is stopped. Side effects include increases in blood pressure and heart rate, dry mouth, constipation, and insomnia. Orlistat inhibits

gastrointestinal lipases, thereby reducing fat digestion and absorption by $\approx 30\%$. Side effects are related to fat malabsorption (steatorrhea with high-fat meals and modest decreases in serum levels of fat-soluble vitamins). With orlistat, weight loss is also typically modest (3.2% more than placebo). Recently, this drug was approved by the Food and Drug Administration for use in adolescents. Dietary "supplements" or herbal medicines are popular, accounting for more than \$1 billion of US consumer spending annually, but are unregulated and untested. Herbal supplements commonly used for weight control include ephedra (Ma Huang), ginseng, chromium, hydroxy citric acid, dehydroepiandrosterone, hydroxymethyl butyrate, chitocan, and St. John's wort. Although adolescents and families may assume that "natural" products are safe, some of these substances may have significant safety issues (14). Therefore, physicians should question their patients about the use of these substances and inform them of possible risks.

Surgery

Over the past 15 years, surgically induced weight loss has emerged as an important option for adults with severe obesity. In contrast to poor long-term success rates for nonsurgical treatments of obesity, surgical approaches generally produce durable and substantial weight loss. More than 80% of patients lose at least half of their excess body weight during the first year, and many of the medical complications of obesity, including diabetes mellitus, hypercholesterolemia, hypertension, and obstructive sleep apnea, resolve (15). Surgical operations reduce gastric capacity, thereby restricting calorie intake, and include Roux-en-Y gastric bypass, vertical banded gastroplasty, and adjustable gastric band. Complications of surgery include anastomotic strictures, incisional hernias, small intestinal obstruction, pulmonary embolism, protein-calorie malnutrition, and gallstone formation. Long-term follow-up, including monitoring of selected micronutrients, particularly iron, and vitamin B₁₂, is required. Limited data on surgery in obese adolescents suggest that short- and long-term outcomes and complications are similar to those seen in adults (15). Nonetheless, little is known about the long-term effects of weight loss surgery in young people, who may have unique metabolic and psychological responses to this intervention.

Goal

Investigate the efficacy of nutritional, pharmacological, and surgical strategies and their short- and long-term outcomes.

1. Diet

Well-designed multicenter studies are needed to determine whether ad-libitum, low-GI diets can prevent

and control obesity in the long-term. Studies are needed to determine the long-term outcomes of hypocaloric, ketogenic diets such as a PSMF diet in severely obese children and the optimum recommended balance of fats, sugars, carbohydrates, and complex carbohydrates for the prevention of obesity.

2. Drugs

Well-designed multicenter studies are needed to determine the safety and efficacy of drug treatment in the long-term control of obesity. Studies should (1) determine and standardize the best techniques for dietary restriction and behavioral counseling for use in multicenter studies of pharmaceutical products in children, (2) determine which overweight children are most likely to benefit from pharmaceutical intervention, (3) determine the prevalence of dietary supplement use and the risks of supplement use in overweight children, and (4) educate adolescents and parents about the potential risks of herbal and dietary supplements.

3. Surgery

Researchers will define and study criteria to determine which severely obese children should be considered for bariatric surgery, understand when it is appropriate to perform bariatric surgery on obese adolescents without life-threatening or otherwise significant morbidities, determine the optimal surgical procedure in adolescents, understand the psychological and quality-of-life changes in adolescents who undergo bariatric surgery, and understand the long-term medical and nutritional complications in adolescents undergoing bariatric surgery.

Plans to Achieve the Goals

1. Diet

Because the goals related to the role of the GI are primarily research focused, it will be necessary to promote research in this area and advocate for funding. Practitioners using a PSMF diet in children should be encouraged to collect long-term outcome data.

2. Drugs

Partnering between pediatric gastroenterology research groups and the pharmaceutical industry is necessary to develop high-quality, well-designed publishable research studies to define better the safety and efficacy of pharmaceutical therapy for the treatment of childhood obesity.

3. Surgery

A database of multicenter experience of adolescents receiving bariatric surgery should be developed. Careful multidisciplinary assessment (surgical, medical, anesthetic, nutritional, and psychiatric assessment) is re-

quired before this option is considered, and long-term follow-up should be ensured.

Public Education

The recent rapid rise in obesity cannot be explained by changes in genetic makeup. The health education focus of the past two decades to reduce fat intake has had minimal impact, and the public has been exposed to a series of conflicting messages, some with little scientific basis. When specific dietary approaches are supported by sound science, focused and consistent public education efforts should be undertaken.

Unregulated direct marketing of herbal supplements to the public has created a risk of exposure to substances with little evidence for efficacy, and potential risks for toxicity, at considerable cost to the consumer. Public education to increase the awareness of these issues should be undertaken.

Goals

Create consistent, scientifically-supported messages for public education about dietary treatments for obesity and the potential risks of herbal supplements and unhealthy dieting practices.

Plans to achieve these goals:

1. Assess and respond to misleading messages in the media.
2. Promote public awareness about unhealthy dieting practices and disordered eating.

Education of Healthcare Providers

The safety and effectiveness of weight loss drugs and herbal supplements in adolescents and children is not established. Although multicenter trials of sibutramine and orlistat are currently underway in adolescents, benefit from these drugs is likely to be modest, and the drugs are likely to have a limited role in the treatment of children with obesity, including those with severe life-threatening complications. However, as we come to understand the biological determinants of body weight, more effective drugs may become available, which, after careful study, may become an important treatment option.

Weight loss surgery may be an appropriate last-resort option in carefully selected, severely obese adolescents, particularly those with severe obesity-related morbidities. More data on the long-term risks and benefits are needed to establish practice guidelines in children. Careful multidisciplinary assessment (surgical, medical, anesthetic, nutritional, and psychiatric) is required before this option is considered, and long-term follow-up should be ensured.

Goals

Educate health care providers about scientifically-supported treatments for obesity and its complications.

Plans to achieve these goals:

1. Professional education and updates on appropriate use of pharmacological and surgical measures to treat obesity as dictated by ongoing scientific studies of these modalities.
2. Strengthen communication between researchers and health care providers for this purpose.

CONCLUSION

Obesity is a complex disorder, with environmental, genetic, and developmental origins, and medical, psychosocial, and economic consequences. Substantial advances in scientific understanding, clinical interventions, and professional and public education will be needed before the epidemic can be reversed. The goals outlined above constitute immediate targets for efforts in each of these arenas, but there are many important secondary targets that must be addressed by the world health care community.

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