Prevention Conference VII
Obesity, a Worldwide Epidemic Related to Heart Disease and Stroke
Group I: Worldwide Demographics of Obesity

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Current concerns about the increased risk of cardiovascular and other diseases induced by excessive weight gain in children and adults have been highlighted by the Surgeon General's report on the problem of obesity in the United States.[1] This call to action followed a global analysis of the problem of excess weight and how to define and combat it that was undertaken by the World Health Organization (WHO) in 1997[2] and an analogous National Institutes of Health (NIH) assessment and reclassification of US rates of overweight and obesity in 1998.[3] It is generally accepted that body mass index (BMI), or weight in kilograms per square meter of height, is a convenient measure of an approximate height-independent index of both children and adults' weight for height and provides a crude indication of the body's fat content. It is becoming clear that different ethnic groups have different proportions of fat-to-lean tissues at equivalent BMIs[4,5] and that the magnitude of the multiple comorbidities associated with higher BMIs also may differ among different ethnic groups for reasons that may reflect the impact of environmental–genetic interactions. Nevertheless, current international comparisons use a standard format and classification system.

In all societies a spectrum of BMIs exists for children and adults of all ages. Individual positions within the percentile range tend to remain the same as children grow and adults steadily gain weight. As the average weight of children and adults increases, so does the spread of BMIs, with a marked progressive increase in the numbers with very high BMIs (see Figure 1). Thus, the escalation in obesity rates reflects the upward shift in body weights of the whole population in response to environmental changes. Adults with a BMI of 18.5 to 24.9 are categorized as being of normal weight, on the basis of international analyses of the health impact of different BMIs in men and women. In all societies with extensive cohort studies, however, the risk of comorbidities tends to rise beginning at a BMI of ≈20. Thus, the specifications of overweight (BMI >25) and obesity (BMI ≥30) are arbitrary. Asian expert groups are concerned about higher risk, so Indian physicians and Japanese authorities have set the clinically relevant cutoff points for greater risk of diabetes and cardiovascular disease at a BMI of 23 for overweight and a BMI of 25 for obesity.[6,7] Chinese medical professionals have identified a BMI of 24 as overweight and a BMI of 28 as obese.[8]

On the basis of the standard WHO adult classification system, it is estimated that in the United States, overweight and obesity combined (BMI ≥25) affect 60% of the population; 27% of US adults are obese (BMI of 30).[9] This statistic reflects a marked increase since the late 1970s, when the combined prevalence of overweight and obesity was 47% and the prevalence of obesity was 15%.[9] This is a population-wide phenomenon, with relatively similar trends by ethnicity and socioeconomic status.[10] Trends in diabetes in the US population reflect trends in obesity.[11] The prevalence of obesity is somewhat lower in the western region of the United States as compared with the rest of the country and is lower in urban and particularly suburban areas as compared with rural areas.[12]

Nearly 30% of the US population is composed of diverse ethnic groups that are broadly categorized as black or African American, Hispanic or Latino (including primarily Mexican Americans, Puerto Ricans, Cuban Americans, and persons from Central America), Asians (including persons with ancestry from or who were born in any part of the Asian continent), Pacific Islanders, American Indians or Alaskan Natives, and Native Hawaiians. This proportion will increase

This paper represents a summary of a scientific conference sponsored by the American Heart Association. The opinions expressed in this paper are those of the authors and do not necessarily represent those of the editor or the American Heart Association. The publication of these proceedings was approved by the American Heart Association Science Advisory and Coordinating Committee on June 1, 2004. All writing group members were required to complete and submit shortly before the conference a Faculty Disclosure Questionnaire. These disclosures can be found as an appendix to the Executive Summary.

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The Executive Summary has been printed in the November 2, 2004, issue of *Circulation* (*Circulation*. 2004;110:2968–2975). The reports of Writing Groups II through IV are available online at http://www.circulationaha.org (*Circulation*. 2004;110:e471–e475; e476–e483; and e484–e488).

(*Circulation.* 2004;110:e463-e470.)

***Circulation* is available at http://www.circulationaha.org** **DOI: 10.1161/01.CIR.0000140125.26161.49**

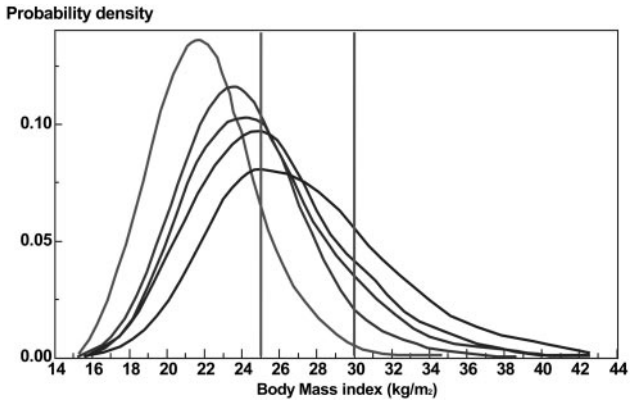

Figure 1. The relationship between the shift in BMI distributions and the increasing prevalences of overweight and obesity. The figure illustrates the 5 quintiles of BMI distributions found by Rose[63] in the Intersalt Study of 52 communities worldwide.

to nearly 40% over the next 2 decades.[13] The prevalence of obesity varies considerably among these ethnic minority populations, and therefore overall US population data provide an incomplete picture. For example, Table 1 shows the distribution of overweight and obesity in non-Hispanic white, non-Hispanic black, and Mexican American men and women in the US population.[14] The prevalence of overweight and obesity is highest in black and Mexican American women and Mexican American men. Among persons with a BMI ≥30, the distribution is highest for black women.

Data on other ethnic minority populations are less current, less nationally representative, or available based on self-report. When compared with US whites, however, clear evidence exists of an excess of obesity in one or both sexes among Puerto Ricans, Cuban Americans, several Native American tribes, Pacific Islanders, and Native Hawaiians.[3] In contrast the data for Asian Americans (including Americans of Chinese, Filipino, Korean, Vietnamese, Japanese, and Asian Indian descent) showed median BMI levels similar to or substantially lower than those in blacks and whites,[15] although among Asian American immigrants BMI increases with the duration of residence in the United States.[15] The prevalence of obesity decreases with increasing educational achievement or family income in the US population overall. This inverse gradient is most pronounced in non-Hispanic white women; in men, those with the lowest incomes are the least likely to be obese.[12] Excess obesity generally is observed among women in ethnic minority populations regardless of socioeconomic status. An association of food insecurity with overweight also has been reported in US women.[16]

TABLE 1. Age-Adjusted Percent of Overweight or Obese US Men and Women ≥20 Years of Age in 3 Ethnic Groups by BMI Classification, 1988 to 1994

BMI Range*	Non-Hispanic White	Non-Hispanic Black	Mexican American
Men			
25–29.9	39.9	36.2	44.3
30.0–34.9	14.4	14.1	17.8
35.0–39.9	3.4	4.1	3.6
≥40	1.7	2.5	1.1
Total	59.4	55.5	67.8
Women			
25–29.9	23.7	29.6	33.2
30.0–34.9	12.8	19.1	21.1
35.0–39.9	6.2	10.3	7.9
≥40	3.2	7.4	4.5
Total	48.9	67.4	66.7

*BMI range: 25.0–29.9, overweight; 30.0–34.9, class I obesity; 35.0–39.9, class II obesity; ≥40, class III obesity.

From Flegal et al.[14]

In Europe, as in many other parts of the world, obesity is obviously a heterogeneous condition. The definition of what constitutes "European countries" has changed with developments in eastern and central Europe and in the wake of the conflicts in central and southeast Europe. Several new countries have been established, complicating opportunities to obtain accurate prevalence and incidence data in all age groups, in varying socioeconomic settings, and in both sexes. Table 2 shows a recent update from the International Obesity Task Force (IOTF).

Countries in the Middle East have sometimes been included in a wider definition of the European region. The prevalence of obesity varies widely. Some of the highest obesity figures (BMI >30) can be found in eastern Europe and countries in the Commonwealth of Independent States, whereas in countries such as Romania and the former Yugoslavia, >30% of adult men and women are obese.[17] In most European countries women are more obese than are men, with a few exceptions, such as Hungary, where obesity seems to be twice as common in men as in women for reasons that are not understood.

Mediterranean countries have long been considered of interest with regard to lifestyle factors, diet, and longevity. It is obvious, however, that no single Mediterranean diet exists because there is no single such lifestyle that varies markedly from countries such as Greece and Israel in the east to the north African countries, Malta, and Spain in the west. In Greece the prevalence of obesity in both men and women is about twice that of men and women in Italy, France, and Spain. England and Scotland have the highest prevalence data in the region. Denmark, Norway, and Sweden are in the lowest part of the distribution, with prevalence data of ≈10% for men and ≈12% for women. Interestingly, however, the prevalence data for neighboring Finland, which is widely known as a country with some of the highest rates for cardiovascular disease, are ≈50% higher than rates in other Nordic countries.[18–20] The reasons for this are not known but genetic factors probably play a role in obesity that is similar to that played in the prevalent hyperlipoproteinemic problems in that country.

Data from the eastern European countries are unsystematic but show considerable prevalence of obesity. In some countries, such as Bulgaria, the data also show a strong link to type 2 diabetes mellitus. Data on socioeconomic aspects, which make it possible to compare countries, are not available, but in general the impression is that in the most affluent countries

TABLE 2. BMI in Adults From European Countries

	Overweight, % (BMI 25.0–29.9)		Obesity, % (BMI ≥30)	
Country	Male	Female	Male	Female
Austria	48	29	12	17
Belgium	...	12	19	...
Bulgaria	37.7	27.7	10	9.2
Croatia	50.9	33.3	16.3	16.2
Czech Republic	48.5	31.4	24.8	26.2
Denmark	38.2	20.2	8.8	5.9
Germany	48.1	31.3	18.8	20.3
Finland	48	33	19.8	19.4
France	35	20.3	8.3	7.7
Hungary	42	28.3	21	21.2
Greece	51.1	36.6	27.5	38.1
Iceland	47.4	16.8	36.9	18.3
Israel	43.5	30.3	14.7	20.9
Italy	39.6	25.0	6.5	6.3
Italy (rural village)	51.8	39.8	19	34.3
Latvia	41	33.1	9.5	17.4
Lithuania	41.8	32.6	11.4	18.3
Malta	46	32	22	35
Netherlands	42	29.1	9.9	8.5
Norway	50.4	28.8	12.7	9.5
Portugal	42.3	31.9	13.2	16.2
Romania	38.8	31.5	21.1	27.4
Russian Federation	34.7	31	9.6	25.4
Slovakia	37.8	23.6	13.1	13
Spain	59.9	48.1	11.8	15.7
Sweden	51.2	41.6	10	11.9
Switzerland	33.1	17.1	6.1	4.7
Tajikistan	17.8	11.4	3.2	2
Turkey	37.3	35	11.8	24.4
United Kingdom (England)	43.9	32.8	18.7	21.1
Uzbekistan	10.2	8.9	8.4	6.1
Yugoslavia	28.1	28.4	25.5	40.9

Data compiled by IOTF from published sources and personal communications. Updated data may be viewed at www.iotf.org.

in the region, as in other developed regions, obesity is more prevalent in lower socioeconomic groups.

In the European Union it has been estimated that overweight is third—after alcohol and tobacco—in attributable factors or the percentage of disease that could be avoided by eliminating the problem. Interest is being focused on the health economic consequences of obesity, particularly the rapidly increasing prevalence of type 2 diabetes mellitus.[21,22]

In summary, the present situation in Europe is heterogeneous with regard to BMI distribution, lifestyle, and health economy. Overweight and obesity are increasing rapidly in most countries, and health economic consequences are now appearing.

The prevalence of obesity has been increasing in Australia, particularly over the past 20 years. A number of surveys have allowed this increased prevalence to be plotted. The National Heart Foundation Risk Factor Surveys in 1980, 1985, and 1989[23] surveyed the major metropolitan areas. In 1995 the National Nutrition Survey[24] measured a representative population sample, and more recently the Australian Diabetes, Obesity, and Lifestyle Study (AusDiab),[25] a nationally representative survey, measured the prevalence of obesity and diabetes in adults aged 25 to 65. In 1980 the prevalence of obesity was 8% in women; in 2000, the prevalence had increased to 21.8%. In men the prevalence was 9.3% in 1980 and 19.1% in 2000. Currently the prevalence of obesity is 20.5% in Australian adults. Among men 67.4% have a BMI >25; among women, 52% have a BMI >25. The major increase in obesity has occurred since 1989. A number of reasons for this exist, including a decline in activity (reported by the Australian Institute of Health and Welfare)[26]; and although a decrease in dietary fat intake has occurred, daily energy intake has increased.[27]

In the 1990s, among Chinese adults aged 20 to 70, the prevalence of overweight (BMI 25.0 to 29.9) was 22.4%; prevalence of obesity (BMI ≥30) was 3.01%. In men the prevalence of overweight was 20.4%; the prevalence of obesity was 2.04%. In women the prevalence of overweight was 22.4%; the prevalence of obesity was 3.89%.[8,28] In 1992 urban-rural differences were evident when the mean BMI of the urban population was 23.57 compared with 21.94 for rural communities.[29] Because China is a country in economic transition, dietary fat intake increased during the 1980s and reached ≈30% but has remained stable since then. In 1998 the average energy share from fat was 28.6% in cities.[30,31] The trend of overweight and obesity increased rapidly in the past 17 years (Table 3). In the southern part of China (Guangzhou, Shanghai) the prevalence of overweight was once low, but the rate of increase is higher than in the northern part of the country.[32] Even in the poor rural area of Shaanxi, the prevalence of overweight reached 10% in 1998.

A meta-analysis of the cross-sectional studies indicated that the relative risk of hypertension for overweight and obesity was 2.5 and 3.3, respectively; for type 2 diabetes mellitus the risk was 2.0 and 3.0, respectively; and for risk factor clustering the risk was 2.2 and 2.8, respectively.

A meta-analysis of cohort studies on the morbidity and mortality of coronary heart disease (CHD) demonstrated that for every increase in BMI of 2 kg/m^2, the relative risk of CHD increased 14%; the risk of stroke increased 4%; and the risk of ischemic stroke increased 16%. The relation of BMI and total mortality is J-shaped. Total mortality was high at a BMI of <18, dropping from 822.1 to 364.8/10 000 at a BMI of 24 and rising to 473.9 at a BMI ≥30 in women. Total mortality in men dropped from 1551.0 to 472.9/10 000 at a BMI of <18 to a BMI of 28 and rose to 854.4/10 000 at a BMI ≥30 (Figure 2).

Latin America is well into epidemiological transition (ie, a shift in main causes of morbidity and mortality from malnutrition and infection to chronic diseases). At the same time the region has great diversity across and within countries, with very poor countries, such as Haiti and Honduras, as well as middle-income countries such as Argentina and Chile. In many countries, Brazil and Mexico, for example, there are

TABLE 3. Prevalence of Overweight and Obesity in Chinese Men 35 to 59 Years of Age

	Overweight, %			Obesity, %		
	1981–1984	1992–1994	1998	1981–1984	1992–1994	1998
Workers						
Beijing	31.5	46.2	51.2	1.7	3.9	6.7
Guangzhou	5.9	13.2	21.8	0.2	0.5	1.2
Farmers						
Beijing	15.9	41.0	49.9	1.4	4.4	8.1
Shaanxi	1.3	3.2	10.1	0	0	0.4
Guangzhou	0.5	6.4	11.7	0	0.8	
Urban residents						
Beijing	...	36.0	51.9	...	2.9	7.4
Shanghai	...	19.9	35.2	...	1.2	2.1

Data from Wu et al.[32]

marked disparities in health and economic conditions among social classes as well as among regions of the country.

Overweight (BMI of 25.0 to 29.9) and obesity (BMI ≥30) are common among Hispanic women aged 15 to 49.[33,34] The levels of overweight and obesity ranged from ≈30% to ≈50% in Bolivia, Brazil, Colombia, the Dominican Republic, Guatemala, Honduras, Mexico, Nicaragua, and Peru. In some countries prevalence rates approach those of the United States. In Haiti, the poorest country in the western hemisphere, the levels of overweight and obesity were ≈10% and were similar to those found in sub-Saharan Africa. Obesity was more common in the urban areas of Haiti compared with rural areas and in women with more education compared with those with only primary schooling or less. By contrast, in 1999 obesity in Mexico was as common in urban areas as it was in rural areas and was more common among poorly educated women. Thus, with greater economic development the prevalence of obesity rises and begins to afflict rich and poor alike; in more advanced countries obesity has become more common among poor and less educated people, as is becoming apparent in Mexico. Obesity levels are rising rapidly in some countries. In Mexico the increases have been dramatic. In 1988 the prevalences of overweight and obesity were 24% and 9%, respectively. By 1999 the corresponding values were 35% and 24%.[35]

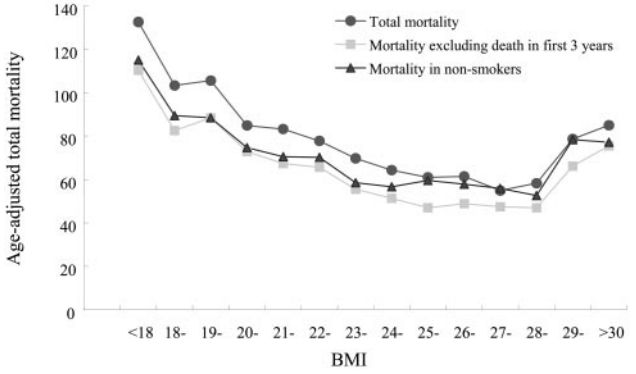

Figure 2. Age-adjusted total mortality by BMI for men in China.

Prevalence of overweight and obesity also is high in north Africa and the Middle East.[32] From 1995 to 1996 31.7% of Egyptian women aged 15 to 49 were overweight; 23.5% were obese.[32] In 1993 a national sample drawn from primary healthcare clinics in Kuwait found a prevalence of obesity of 40.2% among women older than 18 years.[36] In 1998 in Morocco the prevalence for women aged 20 to 60 was reported to be 18.3%; in 1997 in Tunisia the prevalence was 22.7%.[37] The values for men were much lower in both Morocco and Tunisia (Figure 3).

Developing populations in Africa are still battling poverty, food insecurity, undernutrition, and infectious diseases, which are exacerbated in sub-Saharan Africa by the HIV/AIDS epidemic.[38] Overweight and obesity are increasing in the more developed parts of Africa, however, leading to a coexistence of undernutrition and overnutrition in many African countries.

In a review of northern Africa, Mokhtar et al[37] showed that the prevalence of obesity in women in Tunisia and Morocco rose from 1980 to 1997 to 1999, from 8.7% and 5% to 22.7% and 18%, respectively. Rates in men remained low (eg, 6.7% in Tunisia in 1997 and 5.7% in Morocco in 1998 to 1999).

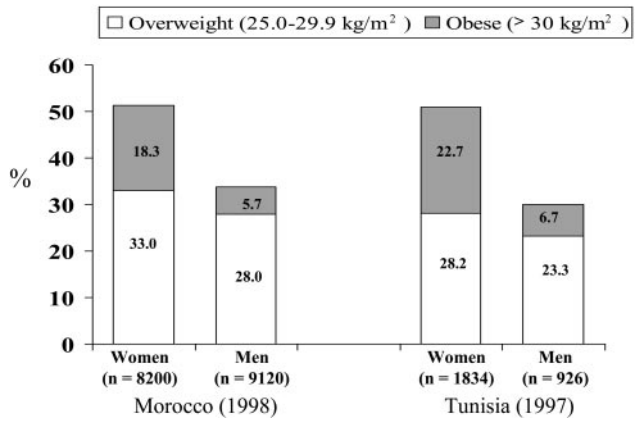

Figure 3. Obesity among women and men in Morocco (aged 18 years) and Tunisia (aged 20 to 60 years). Data from Mokhtar et al.[37]

The prevalence of obesity in children aged <5 years who had a weight-for-height z-score >2 SDs ranged from 1% (aged 2 to 3 years in Tunisia) to 20% (aged 6 months to 1 year in Morocco).

Bourne et al[39] reviewed the data from South Africa, which indicated that in 1998 31.8% of black women but only 6% of black men were obese (BMI ≥30). The prevalence of underweight (BMI ≤8.5) was 12.9% in men and 4.8% in women. The rising trend of obesity in Africa also has been observed in Mauritius, despite national programs to promote healthier diets and increased physical activity.[40] Prevalence studies in which 3677 subjects were followed up from 1987 to 1992 showed that the prevalence of overweight plus obesity (BMI ≥25) increased from 26.1% to 35.7% in men and from 37.9% to 47.7% in women.

In other parts of Africa, especially in rural areas, the prevalence of obesity is still low. In rural Nigeria, for example, only 1.2% of men and 3.2% of women had BMIs ≥25.[41]

The data suggest that obesity (BMI ≥30) in Africa is characterized by a gender difference, with women having 3 to 5 times the rate of obesity that was observed in men. In the overweight range (BMI ≥25), however, these differences are smaller, as seen in the Mauritius data given above.[40] Also, in Tunisia and Morocco the prevalence of overweight in men was 23.3% and 28%, respectively, in 1997 to 1999 compared with 28.2% and 33.0%, respectively, in women during this period. The same pattern was observed in Africans living in Cape Town, South Africa, where the prevalence of overweight was 22% in men and 36.9% in women.[39] These data suggest that overweight and obesity emerge earlier in African women but that African men may eventually reach the same prevalence rates.

Little doubt exists that obesity in Africa is related to urbanization and the associated changes in dietary patterns, socioeconomic circumstances, and physical activity levels. The dietary patterns documented over the last 50 years for Africans living in Johannesburg, South Africa,[39] probably reflect the nutrition transition in many other African countries. From 1940 to 1990 fat intakes increased from 16.4% to 26.2% of total energy, whereas total carbohydrate intakes decreased from 69.3% to 61.7% of total energy.[39] Associated increases in animal-derived protein and decreases in plant proteins and dietary fiber intakes have been described by many authors. The diet of most urban Africans is still "prudent" regarding macronutrient content and energy distribution but often inadequate regarding micronutrient content. The factors associated with inappropriate diets, which lead to obesity and micronutrient deficiencies, include poverty, lack of knowledge and education, and social instability.[39] In South Africa, however, an improvement in household income was positively associated with obesity,[42] illustrating that at this stage of the demographic transition, obesity can be expected to have higher prevalence in the higher socioeconomic strata. The same study also showed that low physical activity was associated with increasing obesity in African women in both rural and urban areas, independent of the level of urbanization.[42]

As in other parts of the world, obesity in Africa also is associated with an increase in risk factors for noncommunicable diseases,[43] although the pattern of emergence of these diseases may be different. It seems that at this stage of the epidemiological and nutrition transition in Africa hypertension, stroke, and type 2 diabetes mellitus are becoming major public health problems[39,44] but that Africans are "protected" against CHD, possibly because of low total cholesterol levels and a high level of high-density lipoprotein cholesterol.[41,44]

Childhood Obesity

Until recently preschool-age children (aged <5 years) have been the main focus of nutritional concern worldwide because they are the most vulnerable to malnutrition. The new focus is on school-age children and the newly emerging problem of overweight and obesity. The Centers for Disease Control and Prevention (CDC) have constructed new US BMI percentile charts for children. Concurrently, the IOTF published BMI reference charts, with definitions of overweight and obesity that conform to the adult cutoff points. The BMI curves are similar, although the definitions of the cutoffs vary.[45] Many published studies are using the IOTF references, and a number of studies compare these new standards.

Overweight prevalence (95th percentile of the CDC standard) in US children and adolescents aged 6 to 19 years is 13% to 14%,[46] or 3 times the prevalence of 4% to 5% observed during the 1960s. An additional 10% of US children and adolescents are at risk of overweight (ie, BMI between the 85th and 95th percentiles).[47] Preschool-age children, particularly those aged 4 to 6 years, also are affected by the trend of increased overweight or obesity.[48,49] Issues related to definitions complicate the interpretation of weight trends for children aged <2 years.

As in adults, the prevalence of obesity in children and adolescents varies by ethnicity. For example, black, Hispanic, and American Indian children are more likely to be overweight or obese than are non-Hispanic white children.[48–50] In recent decades the increase in the prevalence of obesity has been steeper for black children than it has for white children and adolescents, particularly among girls aged 6 to 11 years.[47] Variation in socioeconomic status in overweight prevalence among children is evident primarily in adolescents but with differences by ethnicity; the prevalence of obesity decreases as income level increases in white adolescents but increases with income level increases in black and Mexican American adolescents.[12]

European researchers are particularly concerned that obesity is increasing rapidly in young age groups. In England and Ireland prevalences of 14% and 31%, respectively, have been demonstrated in the 15- to 24-year-old age group. In Malta, Germany, and northern Italy >30% of 10-year-olds were above the percentile, which corresponds to an adult BMI >25. Martorell et al[33,51] documented levels and trends in obesity among women of reproductive age and children aged <5 years in Latin America. The reason for the greater availability of information about these age groups and not others (eg, men, schoolchildren) is that the data come from

national nutrition surveys that are designed to monitor undernutrition in high-risk groups.

In children aged 1 to 5 years, obesity was defined as >2 SDs above the median, using the weight-for-height WHO/National Center for Health Statistics reference, by which 2.3% of children by definition would exceed this value. Of 13 countries in which representative surveys were conducted in the last 15 years, 10 countries had values >2.3%. For example, 6% of children in Peru and 4.8% of children in Mexico were obese. The lowest rate of obesity, 1.4%, was found in Haiti and Honduras.[33,51]

Childhood obesity also has increased in Australia.[52] On the basis of the IOTF international standards[53] and examinations of 3 large studies of children, it appears that 5% to 6% of girls and 5% of boys are obese, and 16% to 18% of girls and 14% to 16% of boys are overweight. The proportion of overweight and obese children has doubled in the past 10 years. Studies in preadolescent Sydney schoolchildren suggest that these prevalence figures are conservative.[54]

Although up to 21% of South African children experience stunted growth because of chronic undernutrition,[55] obesity seems to be an emerging problem in urban areas. In a national sample of children aged 1 to 9 years 4.4% of those living in rural areas and 7.6% of those living in urban areas had a weight-for-height z-score >2 SDs.[55]

In many parts of the world childhood undernutrition and adult overweight and obesity occur within the same family[56] and malnutrition and obesity coexist in the same community. In southeast Asia, southern Africa, and Central America, overweight and obese children may have a range of nutritional deficiencies, such as iron and folic acid-deficiency anemia. Thus, the excess energy storage and nutritionally induced cardiovascular diseases reflect an array of disorders stemming from an inappropriate and low nutritional-quality diet, with several diseases amplified by sedentary lifestyles.

The weight gain that arises from an energy intake in excess of the energy expended in body maintenance and physical activity can occur more readily if social and other environmental conditions overwhelm the normal regulatory control of body weight. The societies that used to have the smallest proportions of both undernourished and overweight adults (eg, China and Japan in the early 1980s) with an average BMI of ≈20.0 had fat intakes of ≈15%, but as fat intakes rose, the national rates of obesity increased.[57]

Within countries the propensity to overweight also rises in individuals with higher fat intakes, whatever the range of dietary items contributing to overall intake.[58] High-fat diets are energy dense and can be readily eaten in excess if portion sizes are large or multiple snacks are consumed. With fat having a poorer impact on satiety than protein or carbohydrate, "passive overconsumption" occurs readily. Since the publication of the original WHO CHD report,[59] which proposed a range of optimum fat intakes of 15% to 30%, diets with a fat intake of <30% often are considered low in fat in western terms. This pragmatic conclusion reflects the recognition that CHD rates increased when dietary fat intake was high; at that stage, the problem of obesity was thought to be of minor public health significance in relation to cardiovascular disease. In many parts of the world, as physical activity levels fall, middle-aged women in particular first begin to display excess weight gain at fat intakes of only 20% to 25%. In the urban populations of China, Japan, southern Africa, and Latin America a substantial proportion of the population is overweight and obese despite supposedly "low" fat intakes of 25% to 30%. Excess weight gain occurs more frequently in societies in which obesity is seen as a sign of affluence and members of those societies traditionally have eaten substantial amounts to cope with the demands of high work rates (eg, agriculture). Higher physical activity levels can substantially limit the risk of weight gain, and some persons can tolerate higher fat intakes if they are particularly active. The type of carbohydrate consumed also is now being seen as relevant to the development of obesity. Diets rich in complex carbohydrates or "fiber" (ie, nonstarch polysaccharide) are protective,[60] and energy-dense diets, as well as drinks that are rich in refined sugars, promote weight gain.[61]

As children become more overweight and obese, the likelihood increases that girls will remain overweight upon entering adulthood. When they become pregnant, their risk of developing glucose intolerance and gestational diabetes increases markedly. Consequently, they then produce heavier babies who are themselves prone to become obese in early childhood and develop adolescent type 2 diabetes mellitus. A vicious intergenerational amplification of higher birth weight, childhood obesity, and early type 2 diabetes mellitus therefore seems to be under way. Asian women are particularly prone to produce small babies with an increased propensity to type 2 diabetes mellitus in later life.[62] Their long-standing intergenerational "adaptation" to a scarce food supply with nations of short and thin children and adults is now exposed to the double burden of an accelerated weight gain in later childhood and the early onset of type 2 diabetes mellitus, which currently affects 12% of the adult slum-dwelling population of Asian cities. A cycle of overweight, obesity, and diabetes is being superimposed on the intergenerational cycle of malnutrition, with persisting maternal micronutrient deficiency and excessive weights likely to lead to even greater health handicaps. This combination of early nutritional programming and later weight gain also seems to be linked to the far greater propensity to abdominal obesity in adults (especially women) in the developing world, but too little is yet known about the importance and determinants of abdominal obesity in these societies and in the analogous ethnic groups living in the United States and Europe.

If current trends in the increase in adult obesity continue, it has been estimated that the prevalence of obesity will be >40% in the United States, >30% in England, and >20% in Brazil by 2025.[64] This trend was established before the rapid increase in childhood obesity, however, and thus can be expected to increase rather than decrease unless successful prevention and treatment strategies are developed.

Research Directions

The main priority should be to develop comprehensive high-quality data on the prevalence of obesity for all countries, particularly in relationship to children, for whom data are scarce in many countries. Another priority should be to identify the relationship between BMI and the comorbidities

of obesity for different ethnic groups and to identify populations at high risk for the development of obesity. Finally, considerable scope exists for researchers to understand better the relationships between dietary and other environmental factors on the prevalence of obesity.

Summary

The increasing prevalence of obesity is clearly apparent throughout the world. Although it is most prevalent in western societies, rapid increases also are seen in the developing world. These increases are seen at all ages, but the increase in childhood obesity is the most dramatic. Specific ethnic groups are particularly prone to obesity. Although increasing BMI is related to the increasing prevalence of comorbidities in all populations, the BMI value for the development of specific comorbidities shows a considerable range across different populations. The reduced level of physical activity associated with affluent societies or urbanization and changing diets are seen as major environmental factors contributing to the increasing prevalence of obesity.

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KEY WORDS: AHA Scientific Statements ■ obesity ■ cardiovascular diseases ■ exercise ■ diet